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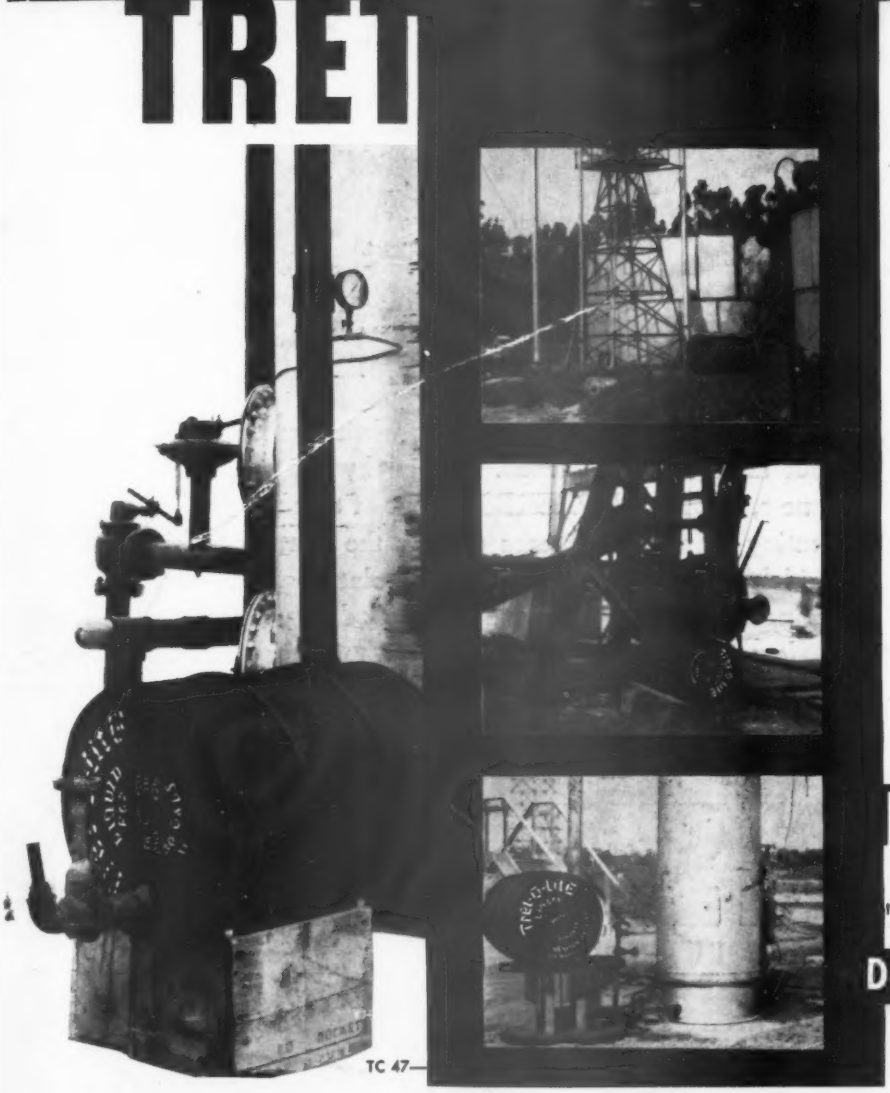

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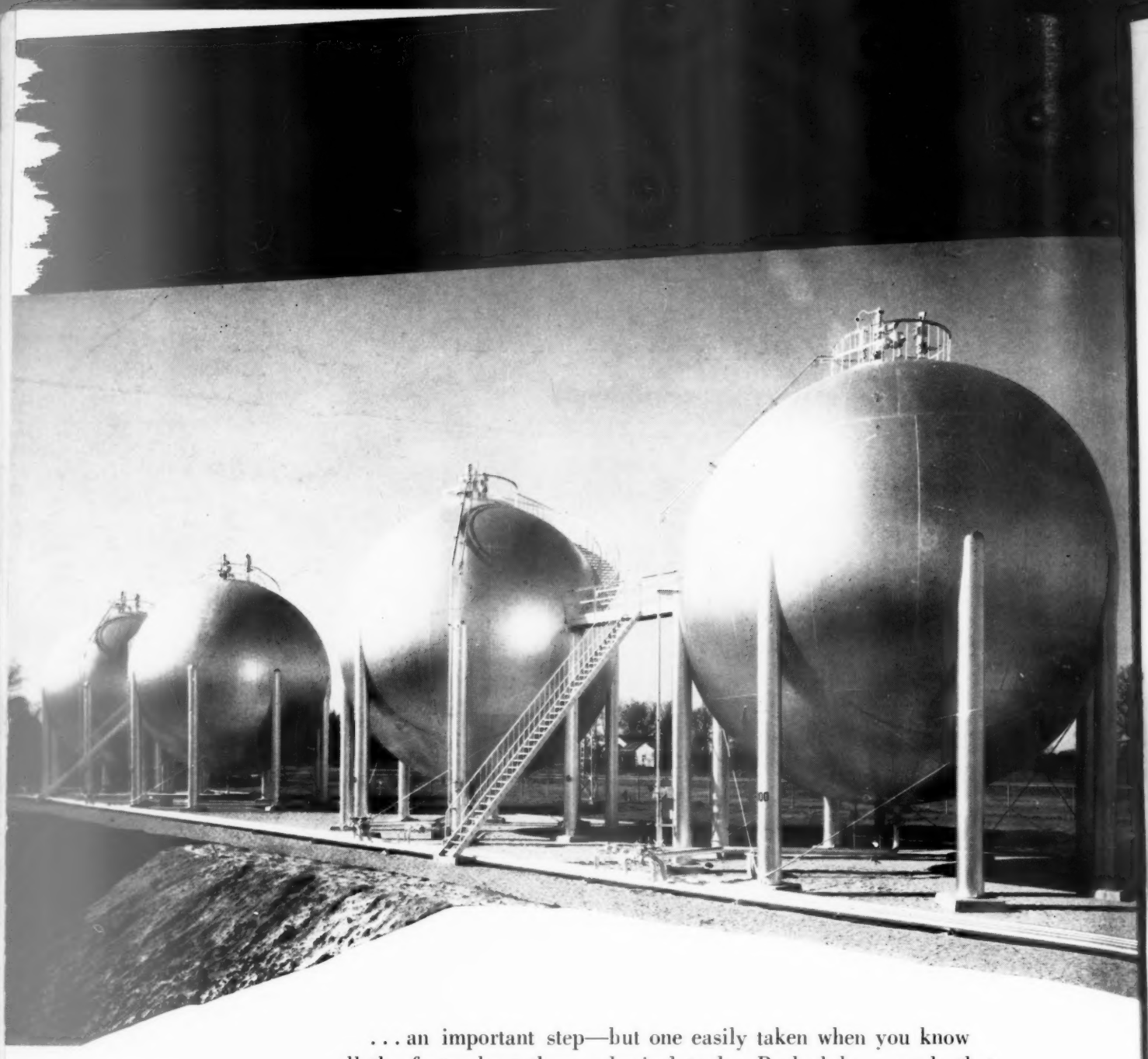

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VOLUME XVIII NUMBER 8

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MEETINGS

May 27-29—LPG Assn., Hotel Sherman, Chicago.
May 27-30—Gas technology course, Texas College of Arts and Industries, Kingsville.
June 1-6—Society Automotive Engineers Summer transportation meeting, French Lick Springs Hotel, French Lick, Ind.
June 2-3—API, Refining Division, Jefferson Hotel, St. Louis, Mo.
June 6—Western Petroleum Refiners, regional, Wichita, Kan.
June 7—California Natural Gas Association, Annual Frolic, Rio Hondo Club, Los Angeles.
June 9—Nomads, Ye Olde College Inn, Houston Texas.
June 9—Society of Exploration Geophysicists, regional meeting, Pittsburgh, Pa.
June 11—Nomads, Jonathan Club, Los Angeles, Calif.
June 16-18—Canadian Gas Association, General Brock Hotel, Niagara Falls, N. Y.
June 16-19—American Society of Mechanical Engineers, semiannual meet, Stevens Hotel, Chicago, Ill.
June 16-20—ASTM, 50th annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
June 23-25—American Chemical Society, regional meeting, Kansas City, Mo.
June 25—API production division, Rocky Mountain district, Mammoth Hotel, Yellowstone National Park.
June 26-27—Rocky Mountain Oil and Gas Assn, Mammoth Hotel, Yellowstone Park.
July 7-8—Michigan Gas Assn., Grand Hotel, Mackinac Island.
July 18—Nomads annual "Whing-Ding", Riveria Country Club, Los Angeles, Calif.
Aug. 25-27—Appalachian Gas-Measurement Short Course, School of Mines, West Virginia University, Morgantown.
Sept. 1-4—ASME, fall meeting, Hotel Utah, Salt Lake City.
Sept. 10—Nomads, Jonathan Club, Los Angeles, Calif.
Sept. 15-17—National Butane-Propane Assn., annual meeting, Jefferson Hotel, St. Louis, Mo.
Sept. 17-19—National Petroleum Assn, annual, Hotel Traymore, Atlantic City, N. J.
Sept. 23-25—Pacific Coast Gas Assn., Coronado Hotel, San Diego, Calif.
Sept. 29-30—IPAA, annual meet, Oklahoma City.
Oct. 7-8—American Gas Assn., annual meeting, Cleveland, Ohio.
Oct. 10—California Natural Gas Assn., Fall meet, Ambassador Hotel, Los Angeles.
Oct. 13-15—American Assn of Oilwell Drilling Contractors, annual, Long Beach, Calif.
Oct. 21-25—Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif.
Nov. 6-7—SAE, Fuels and Lubricants meeting, Hotel Mayo, Tulsa, Okla.
Dec. 1-5—ASME, annual meeting, Chalfonte and Haddon Hall, Atlantic City, N. J.
Jan. 12-16, 1948—SAE, annual meeting, Book-Cadillac Hotel, Detroit, Mich.

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OIL IMPORT POLICY

A significant statement on an oil import policy was made by L. F. McCollum, Coordinator of Producing Activities, Standard Oil Company (New Jersey), before the Independent Petroleum Association of America, Jackson, Mississippi, May 9, 1947. So far as the implementation of an oil import policy is concerned, he had only one conclusion, and that he drew from a consideration of foreign oil development operations and supply. It was: "There is no threat to justify such action now, no reason to implement an import policy when that is one of the least of the problems which confront us today.

"In my view, the really important problem facing the independent producers of this country, as well as the major producers and all other branches of the domestic industry, is not the effect of foreign oil developments over the next few years, but whether we here at home are going to be able to meet the critical demands which will be placed on us to supply enough oil products.

"I do not want to take the position that attention should never be given to the import situation, but I do believe that the figures show convincingly that it will not become a problem for many years. It seems to me that for the time being we can safely rely on the policies and principles which have been stated many times—policies which have been endorsed by your association, the PIWC, the API, and many others . . .

"Therefore, rather than tackle the complicated problem of regulating imports in relation to the domestic industry, at a time like this when it is a purely academic problem, we should be much better advised to extend our efforts and energy in meeting the far more immediate and pressing problems here at home. I might go further than that and say that I hope we can solve that immediate problem well enough so that, if imports ever do become a threat, the industry will be still sufficiently healthy and independent to have a voice in what is done. Let me expand further on what I mean.

"The major crises in our industry in the recollection of most of us have been an oversupply of crude oil at the source. A great deal of our effort has been directed to solving this problem without getting an unnecessary encroachment of federal control in the price and supply of crude oil. I think the industry and the public have been fortunate in the way these crises have been met. But today, the threat of federal control may well be coming in through the backdoor of meeting consumer demand for products, rather than through the front door of overproduction.

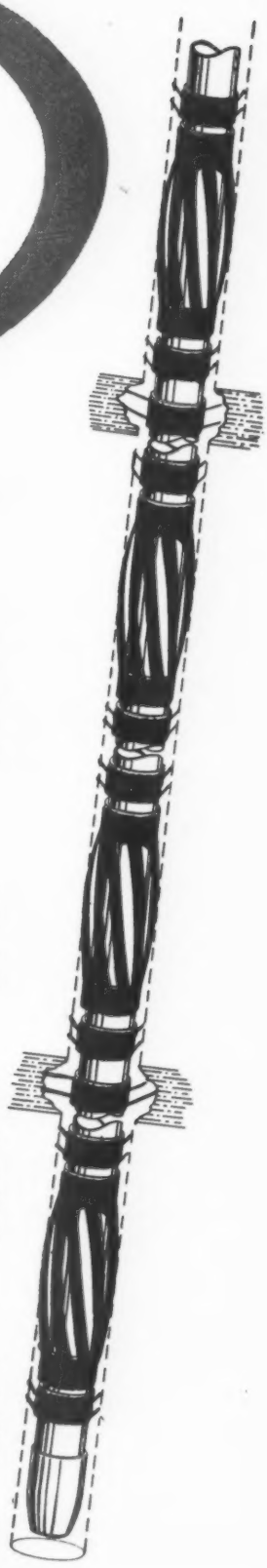
"Prior to World War II the U. S. industry had a surplus production potential of a million barrels a day. This supply was the life-saver which met our military needs. Traditionally, the industry's position has been that demand for oil was met effectively and efficiently largely by 'opening the valves.' Where is that surplus of potential supply today? What valves can we now open?

"The reasons for our situation are well known. The war years brought a combination of low oil prices, of not enough drilling, of inability to keep up with the necessary replacement and expansion of pipeline and refinery capacities. The expected drop in demand, postwar, would have given the industry a chance to catch up. But demand never did drop, and the industry is now really up against it to satisfy the growing consumer needs. Demand today is greater than at any time during the war and it is no news that facilities throughout the industry are strained. Many refineries are finding it difficult to obtain adequate crude oil supplies. Refineries with enough crude are operating dangerously near capacity—so close that a serious disaster such as the one at Texas City would quickly put capacity below the current demand.

"It is conceivable that the domestic industry, rather than fear a 'flood' of imports, may well seek an increase in the very near future. Actually, however, it is doubtful that any substantial increase in imports *could* be made available to help the present domestic situation. The supply problem facing us in this country exists worldwide . . .

"The oil industry has never failed before—I am convinced it will not fail now. But even with good breaks it is going to take lots of hard work, lots of common sense, and lots of cooperation on the part of everyone. I think we can do it. I think we will have the pleasure again of showing the doubters what a free, progressive oil industry can do.

"A healthy, competitive domestic oil industry is our most important asset. I personally, and on behalf of the Jersey Company, want to see foreign oil help the industry stay that way—not hinder it."—K.C.S.



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SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Industry representatives are waging a last ditch fight for continuance of the Interior Department's Oil and Gas Division and the National Petroleum Council, its industry advisory group, because they are fearful that otherwise there will be no forum for planning to meet the threatening fuel oil shortage.

Right now, the industry is taking the first steps toward such planning with the Council's committees appointed to study all angles of the supply-demand situation, to report back at the next NPC meeting.

But the NPC is slated to die on June 30, along with OGD, unless Congress relents and provides funds for the government's oil-coordinating unit. And that would leave no industry planning group, as Interior Secretary Krug told the Senate Appropriations Committee.

"Members of the industry," Krug said, "cannot sit around a table and divide up supplies. That would violate the antitrust laws. And the independents might be squeezed. But with the government sitting in, as with OGD, everyone would be treated equitably and the independents would be protected."

Arguing the need for OGD, Krug declared: "There are already critical scarcities in crude oil and petroleum products. Others, perhaps more grave, are certain to occur." More specifically, he predicted a gasoline shortage within a year or 18 months.

Krug cited the military's difficulties in procuring supplies. (Both the Army and Navy recently wired refiners that the industry had "failed" to meet their current requirements for fuel oil.)

But the senators were reluctant to accept such statements. Senator Cordon (Republican, Oregon) wanted to know why Interior Department couldn't take public lands royalty oil in kind and process it at refineries to meet military requirements. When told that this wouldn't be enough, the Oregon senator suggested making up the difference from Naval Petroleum Reserves.

Industry representatives at the hearings were a bit surprised at such sentiments coming from a Republican senator (and they went unchallenged by any other committee member). But much more radical suggestions were made on the House side during consideration of the Interior Department appropriation bill.

(Incidentally, the House vote to kill OGD was purely an economy move and not because it was feared that the oil unit might some time become an instrument for federal oil control, as was evident from some of the views expressed at the hearings.)

Representative Jones (Republican, Ohio), chairman of the subcommittee on the Interior Department bill, suggested that the petroleum industry should be taxed to provide funds for the government's gathering of oil and gas statistics "like the coal industry was under the Guffey Coal Act."

The Ohio congressman also suggested that, in view of the fact that coal was more plentiful than oil, perhaps the use of petroleum should be restricted until synthetic fuels can be developed commercially as a substitute. And Jones called on Director Sayers of the Bureau of Mines, then testifying, to submit the Bureau's recommendations on legislation to accomplish this purpose.

Sayers, in a formal reply later, said:

"It is the belief of the Bureau of Mines that legislation restricting the use of petroleum is not necessary in the United States at this time. Furthermore, restrictions on the use of oil, unless stated and administered with the utmost care, could stifle some industrial development and result in permanent damage to the country's technical and economic efficiency. On the other hand, governmental encouragement for increased exploratory effort as well as adequate financial support for synthetic liquid fuel pilot and demonstration plant work may eliminate the need for such legislation in the future."

Sayers' statement (which undoubtedly had Krug's endorsement) said this view was supported by progress so far in making oil from coal, then added:

"In making such statements, it is recognized that if a grave emergency of war should occur within the next four or five years then the country's petroleum supply might prove inadequate. It is questionable, however, if present conditions would justify the immediate construction of a vast synthetic industry to meet this danger."

Similarly, Max W. Ball, OGD's director, took issue with steps that might lead to federal oil control. When asked by the Senate committee for his views on the proposed oil production tax, Ball pointed out that the Guffey Coal Act was a federal control measure regulating that industry from mine pit to coal bin. Imposition of such a tax on oil would lead to federal regulation, he said, adding, "I am against it." He urged that OGD and NPC be continued so that the industry, working in partnership with the government—without control, can solve the supply problem now confronting the nation.

(Times have changed when two Interior Department officials say there is no need for federal oil control and oppose suggestions by Republicans for such steps. Indeed, this tends to support a view, held by some observers here, that the petroleum industry has more to fear from the Republicans than the Democrats. The large non-oil states, with bulk of the consumers, ordinarily go Republican while the oil states are usually in the Democratic column. So, a Republican-controlled Congress is no guarantee against federal oil control, if the consumers become aroused.)

In view of the developments, it was not surprising that some industry leaders, lukewarm to OGD in the first place, were found supporting OGD on Capitol Hill. Even if they fail to persuade Congress that OGD should be continued, there is still the possibility that another kind of federal oil unit may be set up by executive order, including provision for an industry advisory group. Secretary Krug feels so strongly that an oil shortage is impending, he could be counted on to take the matter to the White House for action.

One idea is that Truman might issue an executive order establishing an interdepartmental oil board at Cabinet level. (Certainly, it is argued, if the military continues in short supply on petroleum products needed, then the Commander-in-Chief has the authority to take steps to remedy the situation.) The draft of such an executive order is in Interior's files now.

When Krug a year ago was casting about for some means of continuing the government-industry partnership in peacetime, a proposed order was drawn up for Truman's signature. It called for a "Federal Petroleum Security Board" to be made up to the secretaries of Interior (chairman), War, Navy, State and Commerce, plus an advisory committee drawn from the industry. But, at the urging of Ralph K. Davies, then winding up PAW's affairs, Krug shelved the Cabinet-level board idea in favor of Davies' suggestion for an oil and gas coordinating unit within Interior Department. Truman went along with the proposal, writing a letter to Krug "suggesting" that a unit, such as OGD, be set up.

This interdepartmental oil board order may be dusted off and presented to Truman, if efforts to continue OGD fail—especially if the military shows signs of moving in with an oil set-up of their own including an industry advisory group.

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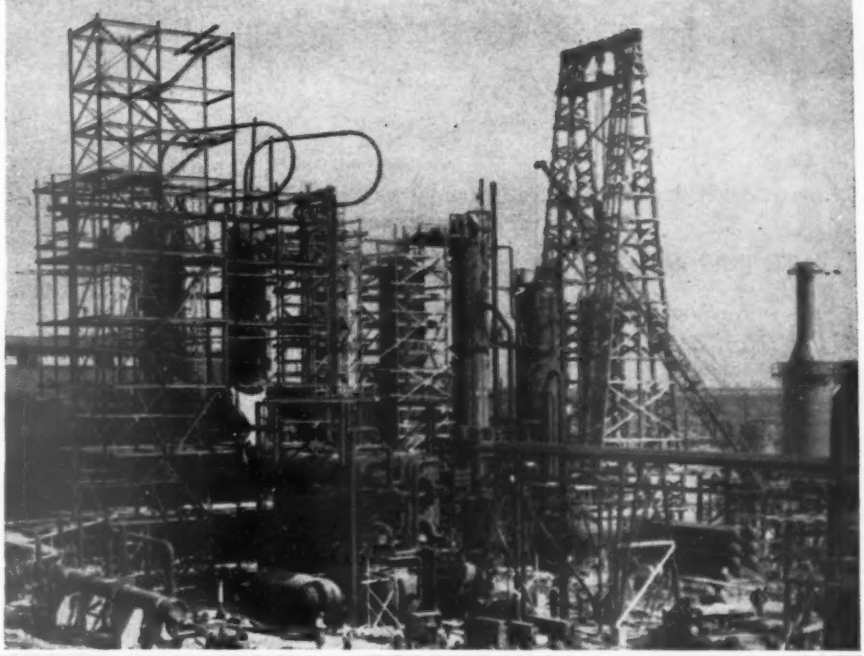

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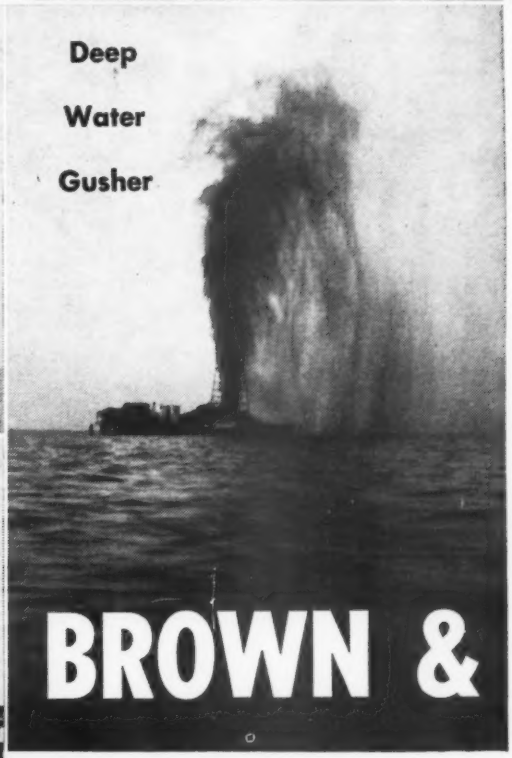

Oil Well Foundation in Gulf of Mexico

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national petroleum situation

By H. J. STRUTH,* *Petroleum Economist*

LOWER FUEL DEMAND. Seasonal decline in demand for fuel oil was marked in April by a drop in daily consumption of about 300,000 bbl. Consumption of light and heavy fuel oils was 2,207,000 bbl daily, against 2,510,000 bbl in March. The decline in fuel oil demand was not offset by the increase recorded in motor fuel consumption, with the result of a net decline in demand for all refined oils of 217,000 bbl daily.

*Editor *The Petroleum Data Book.*

GROWING GASOLINE USE. April consumption of motor fuel averaged about 2,214,000 bbl daily, an increase over March of 112,000 bbl daily. Cumulative demand this year has been about 5 per cent above last year. It is likely that this summer's gasoline requirements will break all previous records and this year's total demand may be 6½ to 7 per cent above the 1946 level. The prospect of an unusually heavy demand for motor fuel this year and the need for accumulation of an adequate back-log of distillate fuels to meet demand next winter foreshadows maximum crude production schedules and capacity refining operations.

MORE STOCKS NEEDED. Stocks of crude oil and refined products at the close of April aggregated 482,600,000 bbl, or slightly less than the combined stock figure on March 31. Seasonal requirements indicate the need for a stock level at this time of at least 500,000,000 bbl, which indicates a shortage of about 3 per cent below normal working levels. To meet next winter's requirements, stocks of refined products should be built up to a level of about 530,000,000 bbl. This will call for full capacity refining operations through September 30 and consequently increasing demands for higher crude production allowables.

DRILLING BEHIND SCHEDULE. While drilling operations in the first four months of this year were about 8 per cent above last year, the total number of wells drilled is well below the rate expected in the light of improved oil prices. Continued shortages of equipment are causing operators great concern and are hampering new field operations.

Comparative Statistics, April, 1947

*All figures are computed on a Bureau of Mines' Basis**

	April 1947(p)	March 1947(p)	April 1946	This year to date	Last year to date	Per cent change
Wells drilling	3,750	3,730	3,310	3,750	3,310	+13
Total wells drilled§	2,370	2,444	2,211	9,528	8,851	+ 8
Development wells	2,038	2,080	1,904	8,092	7,603	+ 6
Oil	1,257	1,315	1,189	5,016	4,747	+ 6
Gas	213	255	196	973	813	+20
Dry§	567	510	519	2,103	2,043	+ 3
Per cent dry	27.8	24.5	27.3	26.0	26.9	— 0.9
Wildcat wells	332	364	307	1,436	1,248	+15
Oil	64	57	57	210	191	+10
Gas	11	11	10	46	35	+31
Dry	257	296	240	1,180	1,022	+15
Per cent dry	77.4	81.3	78.2	82.2	81.9	+ 0.3
Crude supply*	156,400	¶159,400	147,662	609,463	580,510	+ 5
Daily average	5,213	5,142	4,922	5,079	4,836	
Crude demand	147,400	¶156,400	146,577	596,507	576,756	+ 3
Daily average	4,913	5,045	4,886	4,971	4,806	
Crude stocks	242,500	¶233,500	227,013	242,500	227,013	+ 7
Days supply	49	46	46	49	46	
Natural gasoline production	10,200	10,300	9,073	40,935	37,289	+10
Daily average	340	332	302	341	311	
Motor fuel production	62,170	66,975	61,160	254,980	240,677	+ 6
Daily average	2,072	2,160	2,039	2,125	2,006	
Gasoline yield, per cent	39.2	39.3	38.5	39.4	38.0	+ 1.4
Motor fuel demand‡	66,420	65,175	65,578	248,592	236,933	+ 5
Daily average	2,214	2,102	2,186	2,072	1,974	
Motor fuel stocks^	97,550	¶101,800	97,426	97,550	97,426	0
Days supply	44	48	45	44	45	
Fuel oil production	57,850	63,480	60,588	237,909	243,652	— 2
Daily average	1,928	2,048	2,020	1,983	2,030	
Fuel oil demand‡	66,220	77,800	60,436	303,345	270,380	+12
Daily average	2,207	2,510	2,015	2,528	2,253	
Fuel oil stocks	71,900	¶72,700	67,270	71,900	67,270	+ 7
Days supply	33	29	33	33	33	
Refinery still runs	140,760	151,060	139,884	573,317	554,734	+ 3
Daily average	4,692	4,873	4,663	4,778	4,623	
All refined stocks	240,100	¶246,550	239,564	240,100	239,564	0
Days supply	44	43	47	44	47	

Economic Position of U. S. Petroleum Industry

Four Months Ending April 30, 1947

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	10,200	8,982	88
Production (daily crude output)	4,750	4,817	101
Refining (daily still runs)	4,820	4,778	99
Stocks (crude and refined)	¶500,000	482,600	97
Price of crude (per bbl)	$1.88**	$1.92	102

Current Crude Oil Prices

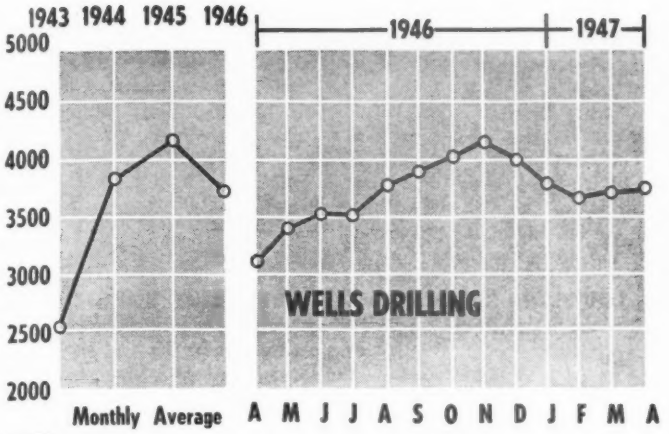
U. S. average	$1.92	Louisiana	$1.92	**Basic crude prices**	
Texas	1.91	Arkansas	1.73	Oklahoma-Kansas (36 gr.)	$1.87
California	1.66	New Mexico	1.70	Texas Gulf Coast (36 gr.)	2.07
Oklahoma	1.93	Mississippi	1.72	East Texas	1.95
Kansas	1.92	Illinois	2.06	West Texas (36 gr.)	1.74
		Other states	2.53	California Signal Hill (26 gr.)	1.71
				Pennsylvania, Bradford	3.91

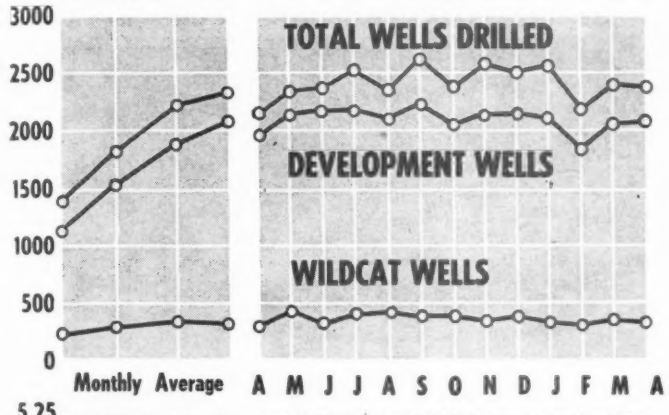
Drilling and Production Statistics by States

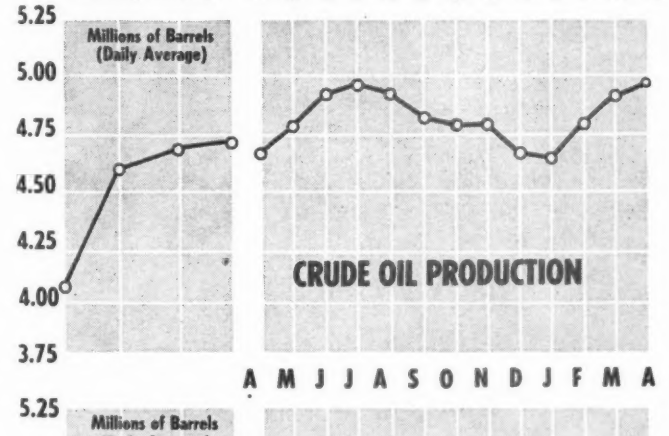
	April 1947(p)	March 1947(p)	April 1946	This year to date	Last year to date	Per cent change
Total wells drilled§	2,370	2,444	2,211	9,528	8,851	+ 8
Texas	710	716	649	2,699	2,558	+ 6
California	190	125	157	640	599	+ 7
Oklahoma	285	330	168	1,298	763	+70
Kansas	188	193	138	792	625	+27
Louisiana	102	93	94	391	411	— 5
Arkansas	20	21	17	78	57	+37
New Mexico	42	52	23	175	129	+36
Mississippi	30	30	18	117	79	+48
Illinois	144	166	202	662	688	—12
Other states	659	718	745	2,736	2,942	— 7
Wildcats drilled	332	364	307	1,436	1,248	+15
Texas	134	159	116	529	464	+14
California	36	26	16	112	80	+40
Oklahoma	59	58	28	280	148	+89
Kansas	23	24	24	101	89	+13
Louisiana	18	23	30	75	82	— 9
Arkansas	4	3	0	15	8	+88
New Mexico	3	3	5	16	21	—24
Mississippi	3	2	2	25	24	+ 4
Illinois	16	21	48	97	139	—30
Other states	36	45	38	186	193	— 4
Daily crude production	4,945	4,861	4,673	4,817	4,604	+ 5
Texas	2,179	2,148	2,036	2,087	1,998	+ 4
California	907	901	863	892	851	+ 5
Oklahoma	381	363	370	368	375	— 2
Kansas	283	267	257	273	254	+ 7
Louisiana	416	419	372	417	375	+11
Arkansas	79	79	77	79	77	+ 3
New Mexico	102	105	100	104	99	+ 5
Mississippi	88	86	57	87	55	+58
Illinois	182	187	208	188	208	—10
Other states	328	306	333	322	312	+ 3

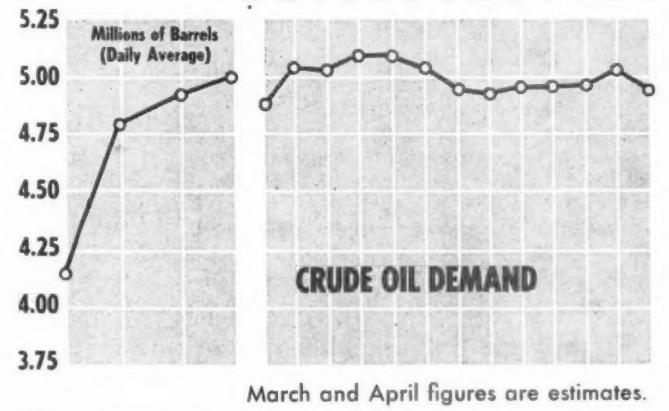
*Unless otherwise stated all figures represent thousands of barrels. ***Does not include input wells. (p) Preliminary. *Includes domestic production and imports.
‡Total demand, including exports. **Price 1926 (Index 100). ^Includes finished and natural gasoline. §Includes service wells. ¶Revised.

Preliminary estimates based upon data furnished by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources

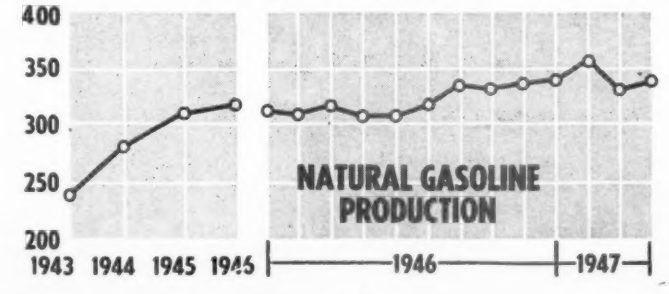


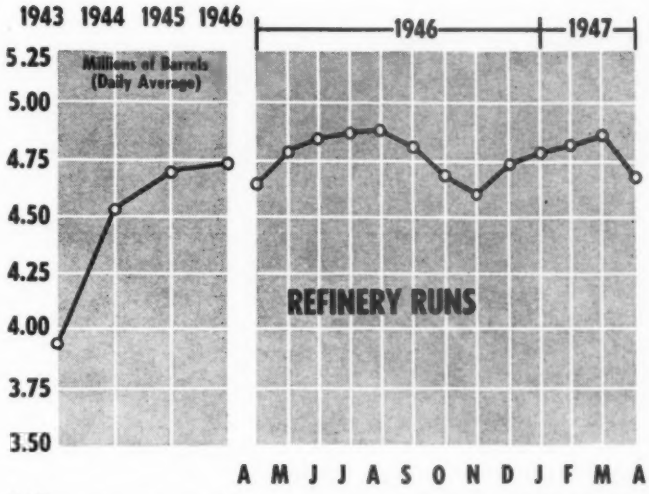


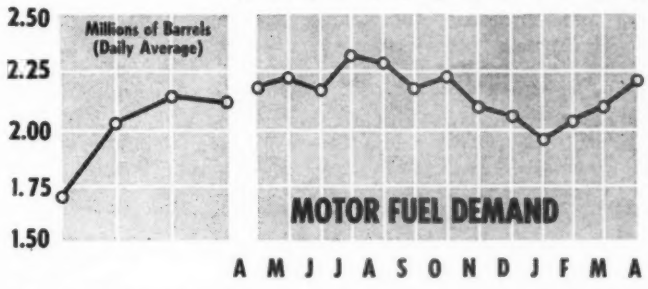


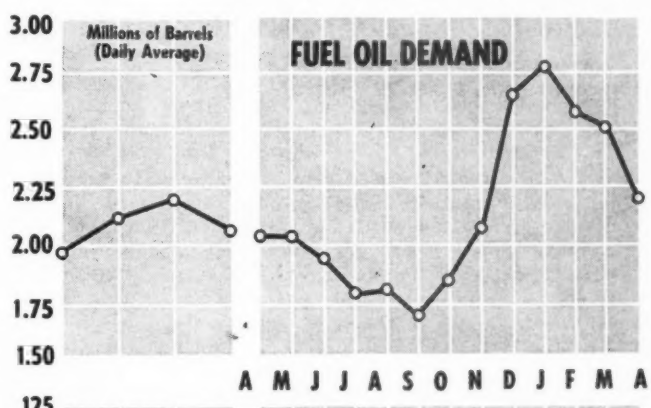


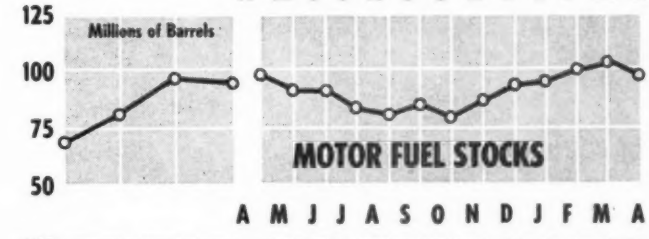
March and April figures are estimates.

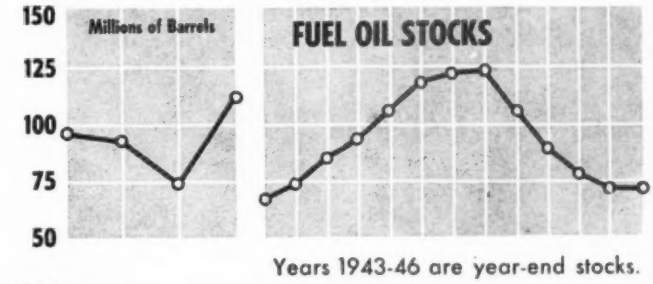




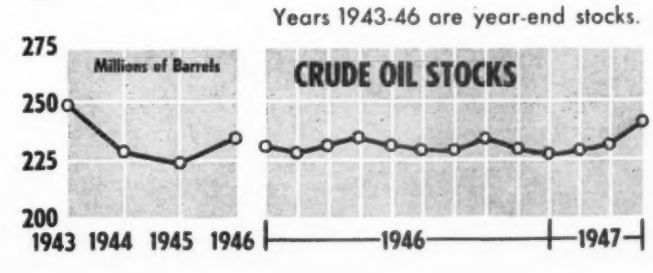








Years 1943-46 are year-end stocks.



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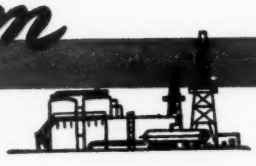

● **SAYS TRUMAN FAVORS EXTENSION OIL COMPACT.** President Truman favors a two-year renewal of the Interstate Oil Compact, according to a statement made by Senator Hatch of New Mexico after a recent visit to the White House. Senator Hatch said he had asked the president to send the customary message to congress urging its ratification, and added:

"He had been in favor of it before and he is in favor of it now."

The compact, first adopted August 27, 1937, requires congressional ratification.

Governor Gates just recently signed the Interstate Oil Compact agreement to make Indiana the nineteenth member.

● **TRANS-JORDAN GRANTS OIL RIGHTS.** Exclusive rights for the exploration and exploitation of petroleum in Trans-Jordan for the next 75 years have been granted to the Petroleum Development Company, subsidiary of the Iraq Petroleum Company, according to authoritative sources in Amman.

The same sources said the southern district of this small middle-east country was considered potentially productive. Petroleum Development was said to have agreed to drill a first test well within 18 months and to have paid £50,000 ($200,000) gold bonus to the Hashemite kingdom for the concession.

Other concession terms include annual rental of £15,000 ($60,000) gold for the first three years, £25,000 ($100,000) gold yearly for the second three years, and gradual increase of the rental to £80,000 ($320,000) gold annually within 15 years.

Company sources said it was hoped to be able to produce a million tons of petroleum annually after three years. They said the agreement provides oil may be exported through Palestine, necessitating construction of a pipe line, possibly to Haifa.

In event oil is discovered, the agreement provides for substitution of royalty payments for annual rental fees.

Iraq Petroleum Company is owned by the Anglo-Iranian Oil Company, Shell, Socony Vacuum, Standard Oil Company of New Jersey, and Campagne Francais de Petrol.

● **PHILIPPINE OIL CONCESSION.** President Roxas had recommended approval by the Philippine congress of an application by Standard Oil Company of New York for a franchise to develop the islands' petroleum resources, according to Philippine government sources.

● **RIGHT OF EMINENT DOMAIN FAVORED.** Legislation to amend the Natural Gas Act so as to permit a pipe line operator who has been granted a certificate of convenience and necessity to exercise the right of eminent domain in order to obtain the necessary rights-of-way for construction and operation of the approved line is proposed in bills recently introduced in the Senate and House of Representatives.

The bills, S. 1028 introduced by Senators Moore of Oklahoma, Stewart of Tennessee, O'Mahoney of Wyoming, and Connally of Texas, and H. R. 2956 by Representative Schwabe of Oklahoma, are expected to be considered in connection with the other amendments to the Natural Gas Act contained in the Moore-Rizley bills. The Moore-Schwabe bills would add the following new section to the Natural Gas Act:

"When any holder of a certificate of public convenience and necessity cannot acquire by contract, or is unable to agree with the owner of property to the compensation to be paid for, the necessary right-of-way to construct, operate and maintain a pipe line or pipe lines for the transportation of natural gas, and the necessary land or other property, in addition to right-of-way, for the location of compressor stations, pressure apparatus, or other stations or equipment necessary to the proper operations of such pipe line or pipe lines, it may acquire the same by the exercise of the right of eminent domain in the district court of the United States for the district in which such property may be located, or in the State courts."

● **LOUISIANA REPEALS ANTI-EXPORT POLICY.** Satisfied after a five-year trial that its policy of opposing the export of Louisiana's natural gas to other states, particularly in the coal regions, has failed to benefit the state, the Louisiana legislature recently adopted a resolution repealing that policy.

● **50TH ANNIVERSARY OKLAHOMA OIL.** Crude oil production in the State of Oklahoma passed the half-century mark on April 15. It was just 50 years ago on that date (April 15, 1897) that the Cudahy Oil Company brought into production "Oklahoma's first commercial oil well"—designated and described as the No. 1 Nellie Johnstone, NE¼ NE¼ NE¼ Sec. 12-T26N-R12E, Washington County, Oklahoma—with an estimated (untested) initial producing capacity of between 50 and 75 bbl a day.

The well, now owned by the Cooperative Refinery Association, is located on the west bank of the Caney River in Johnstone Park in the City of Bartlesville, Oklahoma, and is still producing crude oil at the rate of approximately one-quarter of a barrel per day.

● **ELK HILLS STUDY RELEASED.** A comprehensive report on reservoir oils of Naval Petroleum Reserve No. 1 at Elk Hills, California, prepared by the Bureau of Mines in 1945 at the request of the U. S. Navy to help assure adequate supplies in the Pacific theater, has been released by Dr. R. R. Sayers, Bureau director, as a contribution to petroleum literature of particular interest to California's oil industry.

This report, used by the Navy along with information previously obtained to calculate reservoir performance and oil reserves, is a representative review of the physical properties of reservoir oils in the partly depleted shallow zone of the Elk Hills field.

"Satisfactory correlations of the physical properties of the reservoir oils with the gravities of the produced oils . . . indicate that the relationships may be used to estimate like properties of other oils in the Elk Hills field . . . without analyzing subsurface samples of those oils," according to the report, which was prepared by Alton B. Cook and G. B. Shea, Bureau petroleum engineers.

Flow tests conducted by the Bureau at a new well in the above Bittium sand and a unique application of concepts to this reservoir showed that a substantial source of reservoir energy had been tapped, leading to the drilling of a successful offset well and aiding development after two other offset wells had failed and further drilling plans had been abandoned, the report states. The calculations are presented and explained.

In addition, the report presents a new method for obtaining produced oil samples from pumping wells that minimizes the effect of daily and seasonal variations in temperature on their gravities.

● **REJECTS BIDS ON CANOL NO. 1 PROJECT.** The U. S. State Department has announced that the Foreign Liquidation Commission has rejected all bids for the Canol No. 1 project built in Alaska and Canada during the war. Offers for the section—about half of the total $140,000,000 project—were opened April 28. The high bidder was the Northwest Salvage Company, Edmonton, Canada, which offered to buy the surplus refinery and pipe line facilities for $1,500,000. Maj. Gen. Donald H. Connolly, foreign liquidation commissioner, said none of the 25 bids submitted was "adequate" or in the "best interests of the government." General Connolly said he would re-offer the facilities for sale on a negotiated basis. Although Canol No. 1 cost the government about $70,000,000 in supplies and labor, General Connolly said procurement cost had been about $15,000,000.

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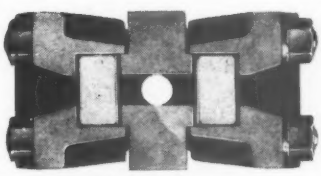

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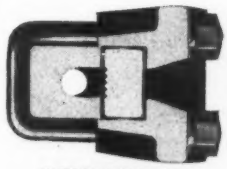
Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.



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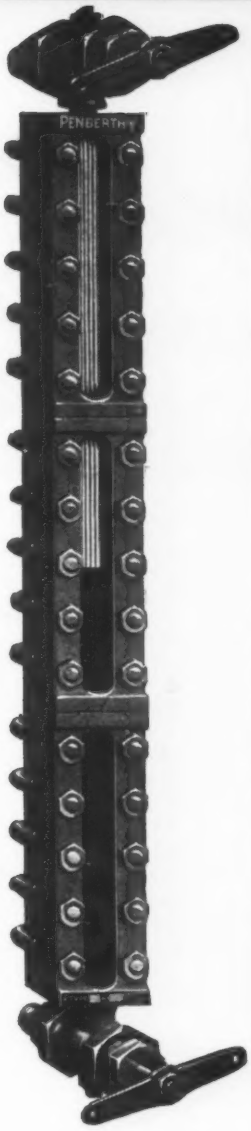

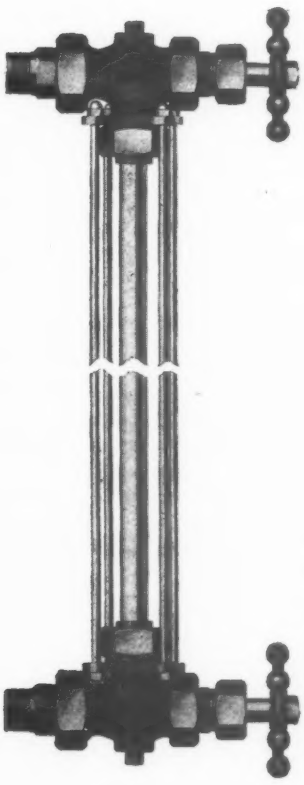

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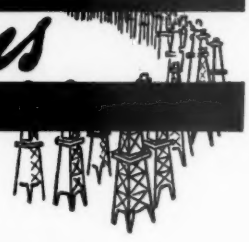
current oil field operations



Exploration wells that have found production.

● **TEXAS.** S. B. Roberts 2 L. S. Tipton, T & P-20-18, Taylor. Discovery well, Saddle Creek pool, 424* bbl from 2694-721 ft.

Andrews & Ryan 1 Allie Chesson, Orange field, Orange. Flowed 150 bbl from new sand 6030-55 ft. TD 7640 ft.

Amerada 1 Sam Adair, C SW-4C37-PSL, Terry. Swabbed 256 bbl oil from 4850-925 ft.

Gulf 421-D Goldsmith, C NE SE 15-44-1s-T&P, Ector. Flowing potential 127.8 bbl 38.5° oil 7980-90 ft. TD 9730 ft.

Fullerton 124 H. M. Wilson, 15-A32-PSL, Andrews. Pumped 156 bbl oil, new sand, Wolfcamp, 8098-9135 ft.

Humble 6 Virginia McCalem, 34-15-H&TC, Wilbarger. First Ellenberger pay in Fargo field. Gas and oil 6248-345 ft.

Marshall & Smith 1 Eva Mae Cole, 94-Y-FR, Upton. Pumped 55 bbl 32° oil from 2816-35 ft. Completed.

Frank Wood et al 1-A Hieserman, 3-HT&B, Wichita. Flowed 248 bbl in 15 hr from 1754-57 ft.

Consolidated 1 Davis, 14-2-Denton CSL, Wichita. Pumped 70 bbl from 5224-34 ft. Completed.

Phillips 1 Cluck, 5-3B-GH&H, Sherman. Est. 9800 MCF gas from 3100-80 and 3015-90 ft. TD 6306 Ft. Completed.

H. W. Snowden 1 Dorothy Andrews, JBH, Archer. Pumped 115 bbl 43° oil Caddo 4591-601 ft. TD 4850 ft.

L. T. Burns 2 Benson Estate "E", 1398-TE&L, Archer. Pumped 100 bbl 43° oil Caddo 4454-600 ft. TD 5231. Comp.

Worth Thomason 2 W. D. Coppie, 35-HT&B, Brown. Pumped 88 bbl in 10 hr from 1237-9 ft.

Mudge 1 Graham Estate, 2201-TE&L, Throckmorton. Flowed 108 bbl 41° oil Caddo 3880-5 ft. TD 4702 ft.

Mid-Continent 1 John Somers, 1½ mile S Agua Dulce, Nueces. Flowed 123 bbl 35° from 5982-8 ft.

Dulaney 22 Puig et al, 55-A, Webb. Pumped 55 bbl 21° oil from 1790-1800 ft. TD 1823 ft. Completed.

Continental 1-D Albert West, Live Oak. Flowed 22.4 bbl condensate, 3 MMCF gas Slick sand, 6780-93 ft. TD 7296.

Cockburn Oil Corp. 1 Wharton Bank & Trust, A. B. & M. Sur., Wharton. Open flow 5 MMCF from 4526-36 ft. TD 5720 ft.

G. E. Sullivan 1 fee, Stratton field, Nueces. New pay at 5875-87. Flowed 32 bbl 43° oil. TD 7020 ft.

Magnolia 1-A El Contesto Unit, LaGloria field, Jim Wells. New pay at 7302-10. Flowed 92 bbl 40°. TD 7800 ft.

Atlantic 1 Mrs. J. R. Parr, No. Minnie Bock pool, Nueces. New pay at 7680-89. IP 30 bbl oil. TD 10,031 ft.

Gulf 1 Miller-Vidor Land Co. et al, 318-JMS, Orange. Oil and gas from 6932-4 ft. TD 8010 ft.

Harvey Oil 1 C. E. Powell, J. Scritchfield Sur., Leon. Pumped 30 bbl 35° in 6 hr. TD 7484.

Hickok & Reynolds 1 Amado Perez et al, Webb. Flowed 1600 MCF from 1266-76 ft.

Skelly 1 Rivers, Nueces, 18 bbl on gas lift from 5992-6000.

J. C. Benedum 1 W. A. Johnson, Ed. Quirk Sur., San Augustine. 750 ft of 40° + in 11 min. from 8156-65 ft.

Progress 1 O. L. Rash, Brazoria. Potential of 134 bbl 26° from 4590-4594 ft. TD 5640.

Mac Drilling 1 Cynthia Payne, San Jacinto. Flowing potential of 76 bbl 36.8° oil from 7682-7708 ft. TD 8260 ft.

Jones & Morgan 3A Loy Sims, West Sinton field, San Patricio. 181 bbl 36.4° from new pay 5136-42 ft. TD 5186.

Fred Turner, Jr. 1 M. M. Fisher, Andrews. Pumped 135 bbl 35° oil from 4340 ft. TD 4505.

Gulf 1-R University, Crockett. Pumped 108 bbl 33.3° oil from Grayburg 1677 ft. TD 1685.

● **OKLAHOMA.** Benton Ross W. Duncan 1 Dugan, SW SE SW 5-5s-11w, Cotton. Estimate 125 bbl oil from 1577-90 ft.

Cities Service 1 Douglass, C NW SE 31-7n-3e, Pottawatomie. Swabbed 20 bbl oil 20 bbl water. PB 4313 ft.

Skelly I Adams, CSW SE 20-13-2w, Oklahoma. Tested 3 bbl white gasoline an hr drillstem 6106-22 ft. Testing.

Texas Co. 1 Chapman-Rosier Com. "B," NE SE NE 25-4-3w, Garvin. Swabbed 43 bbl 41° oil in 12 hr from 7484-7 ft. Testing.

R. Olsen 1 Lewis Ott, C W½ SW SE 2-21n-9w, Major. Flowed 44 bbl distillate from 2nd Wilcox 8005-8124. TD 8124.

J. E. Crosbie 1 Schultz, SW Paden field, Okfuskee. New pay from Earlsboro at 3348-64. Flowed 75 bbl 36°. TD 3364.

Carter 1 Bohanan, NW SE SW 14-2-2w, Garvin. Flowed 50-60 bbl an hr with 1500 MCF a day from 6507 ft.

● **LOUISIANA.** Union of Calif. 1 Landry 29-13s-5e, Iberia. Condensate and gas 11,480-500 ft. TD 11,843 ft. Testing.

● **KANSAS.** Darby & Bothwell 1 Wetzel, SW SW NW 1-16s-20w, Rush. Swabbed 10 bbl oil an hr 3680-90. Sooy conglomerate.

J. M. Huber 1 Womack, NE NW NE 19-28s-6e, Butler. 2 MMCF gas from Bartlesville 2690-97 ft. TD 3191.

Huber 1 Torrance, SW SW SW 19-21-15w, Pawnee. Estimated 35 MMCF gas Arbuckle 3843-57 ft.

Huber 1 O'Connor, CNW NW 16-24-15w, Stafford. Gauged 26 MMCF gas Arbuckle 4061-8 ft.

Solar Oil 1 Tammen, SW SW SW 24-19s-16w, Rush. Flowed 5 bbl an hr from Arbuckle 3700 ft. Testing.

Murphy et al 1 Fee, NW NW NE 32-21s-11e, Lyon. Pumped 35 bbl oil from 1930-42 ft.

● **NEW MEXICO.** Byrd-Frost, Inc. 1 Federal-Hargrove, 4-27n-10w, San Juan. Bailed some free oil at 6722 ft.

Texas Co. 1 W. C. Garrett, NE SE 22-16s-38e. Pumped 15 bbl oil from San Andres 5300-5400 ft. TD 5760.

● **MONTANA.** Union 9 McGuiness Unit, SE NW 6-35n-5w, Cut Bank field. 365 bbl from Madison line, new pay.

● **WYOMING.** Ohio 2 OPC-2, NW SE SE 31-48n-90w, Hidden Dome, Washakie. Pumping 240 bbl Tensleep at TD 4726.

Brinkerhoff & Sohio 1 Tribal, NW NW NW 9-3n-1w. Pumped 847 bbl in 22 hr from Tensleep 6428 ft. TD 6923.

● **ILLINOIS.** Harry Evans 1 Provine, W½ NE NW 3-2n-14w, Richland. Oil, gas, some salt water McClosky lime, 3118-28 ft.

Gilliam & Smith 1 Adams, SW NW SE 10-6n-7e, Effingham. IP 102 bbl from McClosky, 2868-72 ft. TD 2879.

● **INDIANA.** F. A. Calvert et al 1 Hastings, SW SW NW 10-8s-14w, Posey. Drillstem, 120 ft oil 2668-710 ft. TD 2837.

● **MICHIGAN.** Panhandle Eastern Pipeline 1 L. N. Brayton, NE SW NE 1-2n-4e, Livingston. Gas 2500 MCF. TD 3866.

Carter 1 John F. Miller, NE NW SW 11-13n-18w, Oceana. Flowed 363 bbl from Traverse limestone 1720. TD 2096.

● **CALIFORNIA.** Standard of Calif. 2 McGrath, 26-2n-23w, Ventura. Flowed 243 bbl 44° oil 1960 MCF gas. Repetto, 8428-73 and 8632-60 ft. TD 11,505.

Los Nietos et al 3 C & H, 23-3n-21w, Ventura. Flowed 200 bbl 25° oil. TD 5181.

Superior 35-32 Keisson, 32-15s-17e, Fresno. Flowed 195 bbl 31.3° oil 7031-76 ft. Completed.

Amerada 73-7 Anaheim-Sugar, 7-6s-10w, Orange. Pumped 55 bbl in 4 hr. TD 5500.

Standard 24-34 UONPR, 34-30s-23e, Kern. Flowed 172 bbl 41° in 18 hr, Upper Wilhelm. TD 3375.

● **OHIO.** Ohio Fuel 2 D. L. Jadwin, Morgan. Gas 713 MCF from Medina at 3928. TD 3932.

● **KENTUCKY.** Sohio 1 Simon Smith, 14-P-29 Daviess. Pumped 5 bbl from Waltersburg 1058-65. TD 1071.

Carter 1 Josephine Johnson, 5-N-23 Webster. Flowed 70 bbl from McClosky 2151-58. TD 2731.

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pipeline developments

● **TO ENLARGE ROCKY MOUNTAIN LINE.** Rocky Mountain Pipe Line Company, a Continental Oil Company subsidiary, will enlarge its Colorado-Wyoming pipe line at an estimated cost of $2,300,000, it has been announced by W. H. Ferguson, president of Rocky Mountain and executive vice president of Continental.

The expansion of the Rocky Mountain Pipe Line Company's activities follows the recent announcement of a $4,000,000 construction program to enlarge Continental's Denver refinery to twice its present size.

Rocky Mountain's lines now include an 8-in. line from Lance Creek to Cheyenne and a 6-in. line from Cheyenne to Denver.

The enlargement announced will include laying an entirely new 10-in. line from the Horse Creek station north of Cheyenne to Denver, a distance of about 118 miles, and looping with additional 8-in pipe a part of the line from the Guernsey station to Horse Creek. Because of the scarcity of material, the new line will not be completed until late in 1948.

When finished, the enlarged line will handle, with a minimum number of pump stations, at least 26,000 bbl of crude a day. Later erection of additional pump stations will substantially increase the capacity beyond this figure.

Rocky Mountain Pipe Line Company was organized in 1938 to transport oil from the Lance Creek field to Cheyenne and Denver. The present line is 240 miles long. Continental's interest is 55 per cent.

● **SOUTHERN LINE PROPOSED.** The United Gas Corporation, Shreveport, Louisiana, expects to construct and operate a natural gas pipe line system extending easterly from near Hattiesburg, Mississippi, through Alabama, Georgia and northern Florida and into southeastern South Carolina. The overall capital cost of the project has been estimated at $57,126,000. The builder and operator would be one of United's subsidiaries or a subsidiary to be organized.

The service planned is sale of natural gas at city gates for resale in the various cities, towns, communities and rural areas along the route of the proposed line and direct gas sales to main line industrial customers. There is at present no natural gas service in the area proposed to be served.

● **SOUTHEASTERN EXTENSION PLANNED.** Southern Natural Gas Company plans the construction of gas pipe line facilities to extend natural gas service to northern Florida, Southern Georgia, and into South Carolina. Cost of these facilities has been estimated at $25,711,955. Construction is proposed for 1949 and 1950.

The new markets would be reached by building a 225-mile, 16-in. trunk line extending from a point on a proposed Gwinville-Atlanta line to Colfax, Georgia, with various extensions from the trunk line.

● **NEBRASKA COMPANY WILL EXPAND.** Northern Natural Gas Company, Omaha, Nebraska, will make additions to its natural gas transmission system running from Texas through Oklahoma, Kansas, Nebraska, Iowa, Minnesota and South Dakota to increase the daily delivery capacity north of Clifton, Kansas, to 407,000,000 cubic feet of gas daily. Present authorized pipe line capacity is 325,000,000 cubic feet a day. Cost of the project has been estimated at $12,441,000.

Facilities authorized by the Commission's order include construction of a new 2000-hp compressor station at Sunray, Texas, and a new 3200-hp compressor station at Dunnell, Minnesota; installation of an aggregate of 34,200 hp in existing compressor stations in Oklahoma, Kansas, Nebraska and Iowa; 71 miles of 24-in. loop, 27 miles of 20-in. loop and 40 miles of 18-in. main line loop; about 12 miles of 24-in. tie-in line and about 35 miles of 16-in. line to connect the Sunray Station to a main line in Hutchinson County, Texas.

● **GAS LINE NEARS COMPLETION.** United Fuel Gas Company is constructing and will operate about 70 miles of 20-in. transmission pipe line and auxiliary facilities in West Virginia at a cost of approximately $2,970,000. The installation will complete a single high pressure transmission line extending from the Cobb compressor station in Roane County to a connection with a line of The Manufacturers Light and Heat Company in Monongalia County, West Virginia.

The temporary authorization was granted to allow the company to begin construction of the line immediately so that it can be completed by June 1.

● **KENTUCKY FIRM PLANS ADDITIONS.** The Central Kentucky Natural Gas Company has applied to FPC to construct facilities to be used to deliver additional natural gas to The Cincinnati Gas and Electric Company and The Union Light, Heat and Power Company. Costs of the facilities has been estimated by Central Kentucky at $1,933,000. Construction is planned to begin not later than June 1, 1947, depending upon receipt of pipe and other materials from suppliers.

Estimated requirements for gas deliveries during the 1947-48 winter from Central Kentucky to Cincinnati and Union total 123,200,000 cu ft daily, or 31,200,000 more than the capacity of the present facilities. To meet the additional needs, Central Kentucky has asked authorization to construct approximately 23 miles of 24-in. gas transmission pipe line from near Foster, Kentucky, to a point on the Ohio River near Brent, Kentucky, and a multiple crossing of the Ohio River to a connection with a pipe line to be constructed by Cincinnati. The river crossing would connect on the Kentucky side with a pipe line of Union.

● **TO CONNECT WITH BIG INCHES.** United Natural Gas Company, Oil City, Pennsylvania, plans to extend its present pipe line facilities to receive gas supplies from the Big Inch and Little Big Inch lines.

The facilities that the company proposes to install consist of 71 miles of 20-in. pipe line extending from its 12-in. line in Beaver County to the Big and Little Big Inch lines in Greene County, Pennsylvania. Complete cost of the construction has been estimated at $3,737,718.

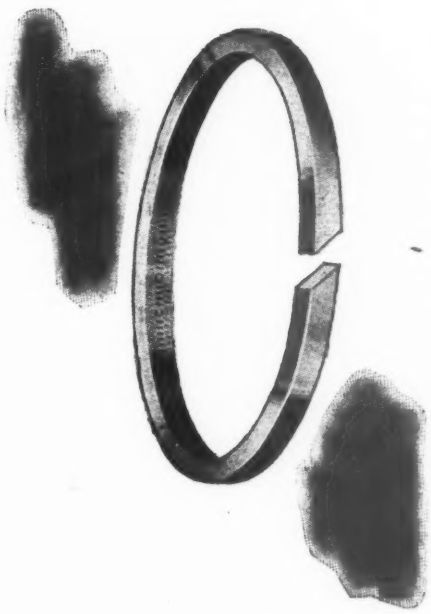
● **TENNESSEE RELEASES INCH LINES.** The Big and Little Big Inch Pipelines were released May 1 by the Tennessee Gas and Transmission Company after transporting 17 billion cu ft of natural gas to the fuel-starved Appalachian area during the winter months. On December 3 the company received right of entry to the properties, and on December 5 gas was turned into the Little Inch line for the first time at Many, Louisiana. On December 11 gas was being delivered in commercial quantities to consumer points in Ohio.

Texas Eastern Transmission Corporation began operation of the Big and Little Big Inch pipe lines under a temporary lease pending permanent possession, taking over from Tennessee, after payment of $4,000,000 to War Assets Administration.

This makes a total of $5,100,000 paid out of a sale price of $143,127,000 due the government, according to E. Holley Poe and his associates in Texas Eastern.

Gardiner Symonds, president of Tennessee, said that without the emergency use of the line there would have been real suffering in the Ohio-West Virginia area during the past severe winter. Besides preventing real suffering in the consumer area, the Government's decision to lease the lines temporarily to Tennessee netted the War Assets Administration more than $1,000,000 in revenue paid in by Tennessee as rental, plus $300,000 in maintenance savings. These revenues bore out Interior Secretary J. A. Krug's previous analysis.

Due to the presence of large quantities of condensed moisture in the line only a 75 per cent flow efficiency was possible. Designed to pump oil, much work had to be done on the lines to ready them for gas transmission. Tennessee Gas paid an average of six cents per thousand for gas used in the system, which meant more than $1,000,000 for producers, land and royalty owners.



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refining and natural gasoline activities

● **ALAMO REFINING BUYS PLANT.** Purchase of the Old Ocean refinery, 100-octane gasoline plant in Brazoria county, from the War Assets Administration for $13,100,000 was announced by the Alamo Refining Company of Houston, a new organization formed to operate the refinery.

Major stockholder in the Alamo Refining Company is the Phillips Petroleum Company of Bartlesville, Oklahoma. Other stockholders are Clayton N. Smith, Houston independent operator; Jack Blalock, Houston attorney; Harry Grebe, Houston petroleum engineer; Ed Doremus, Houston chemist and process engineer, and Butcher-Arthuor, Inc., of Houston, oil producers and transporters.

The Old Ocean refinery was built in 1942-43 at a total cost to the government of $26,252,187 and was operated jointly by the J. S. Abercrombie company and the Harrison Oil company.

● **GASOLINE PLANT FOR ETEX.** Plans for construction of a gasoline plant and two gas pipe lines in East Texas at an estimated cost of $3,750,000 were announced by Rogers Lacy, independent oil man.

Survey and right of way work will begin immediately for a 16-in. line from the Carthage area, Panola county, to Longview, where it will tie into the Big Inch line, Lacy said. The cost was estimated at $1,500,000. A gasoline plant, costing $1,500,000, will be constructed to extract liquids from the gas before it goes into the Big Inch. Another 12-in. line will be constructed from the Waskom area, Harrison county, to Jefferson, where it will connect with the Big Inch.

● **COMPLETE PILOT UNIT.** The Bureau of Mines opened its $2,000,000 oil-shale demonstration plant this month in western Colorado, near Rifle, which Dr. R. R. Sayers, bureau director, says will prove the way for private industry to tap new petroleum sources. The plant is part of the government's five-year $30,000,000 program of synthetic liquid fuels research and development.

● **PANHANDLE REOPENS PLANT.** Panhandle Producing and Refining Company reopened its 5000-bbl-a-day oil refinery at Wichita Falls, Texas, May 1. Romeo E. Muller, executive vice president, said the refinery was closed temporarily because the two companies from which Panhandle purchases had been unable to supply the crude.

● **BILLIONTH BARREL PROCESSED.** The billionth barrel of crude oil was processed in Humble Oil and Refining Company's Baytown, Texas, plant around the first of May. The great coastal refinery charged its first crude to stills in May, 1920. From that time until today it has processed into hundreds of different products 1,000,000,000 bbl of crude oil — enough to fill all of the crude petroleum needs of this entire nation for about 200 days at today's peak level of demand.

Back in 1919 the site where Baytown refinery now stands was a 2200-acre tract of marsh and woodland. The Humble Company purchased the site, and in April of that year started construction on a refinery to run 10,000 bbl a day of grade "A" coastal crude for the production of lubricating oils. After almost a year of construction work the first batch of crude was charged to stills on May 11, 1920. From that day until early in 1924, the refinery was expanded rapidly up to 100,000-bbl-a-day capacity.

● **LAUNCH BIG EXPANSION PROGRAM.** A $45,000,000 modernization and enlargement program at five of its refineries has been announced by W. F. Burt, vice president in charge of manufacturing, Socony-Vacuum Oil Company, Inc.

Construction of new units for the manufacturing of lubricating oils is already underway at Socony-Vacuum's refinery in Paulsboro, New Jersey, and at the Beaumont, Texas, refinery of the Magnolia Petroleum Company, an affiliated company. Other construction will be at refineries in East St. Louis, Illinois, Casper, Wyoming, and Augusta, Kansas. All the new units are expected to be in operation by January 1, 1949, by which time it is estimated Socony-Vacuum's total refinery throughput will be increased to 475,000 bbl daily.

At Paulsboro and Beaumont, construction will include solvent refining units for making lubricating oils and dewaxing plants, power houses and vacuum stills.

At the East St. Louis refinery, which supplies Socony-Vacuum's marketing outlets in a large part of the Middle West, new construction will include a delayed coker and distillation facilities.

The Casper refinery, which was first constructed in 1923, will be practically rebuilt and its capacity doubled. It will have a new 5,000-bbl-per-day thermofor catalytic cracking unit, pump house, distillation equipment, water system, office building and truck-loading rack.

At Augusta the refinery will be enlarged by a 10,000-bbl-per-day thermofor catalytic cracking unit, topping facilities and vacuum stills.

● **CONTRACT FOR TCC UNIT.** Catalytic Construction Company, subsidiary of Houdry Process Corporation, has received a $3,500,000 contract for modernization and expansion of the Socony-Vacuum Oil Company, Inc., White Eagle Division refinery, at Casper, Wyoming. The contract involves the engineering and construction of another Houdry TCC unit with a fresh feed capacity of 4000 BPD and will represent the fourth small-scale post-war TCC unit to be built by industry for the production of better gasoline.

● **MEXICAN REFINERY.** Petroleos Mexicanos, the Mexican government oil monopoly, is expected soon to begin construction of a new 30,000-bbl-per-day refinery at Salamanca, Guanajuato, Commerce Department reports.

● **COMPLETE PLANS FOR SYNTHOL UNIT.** Engineering plans of the synthol plant to be constructed by Stanolind Oil and Gas Company, Tulsa, in the Hugoton field of Kansas, is nearing completion, J. H. Forrester, manager of manufacturing of the company, stated in a paper presented at a meeting of 150 key scientists of the Standard Oil Company (Indiana) and its subsidiaries in French Lick Springs, Indiana.

Forrester said production of gasoline from natural gas on a commercial scale will be a reality in 1949. In discussing the new plant to be built in Kansas, Forrester said:

"The new plant will produce 5300 barrels per day of gasoline. In addition to this amount of high-quality gasoline, by-products made each day will include 800 barrels of fuel oils, 1060 barrels of light hydrocarbons, and a half-million pounds of chemicals."

In discussing the chemical by-products of the synthol process, J. E. Latta of Stanolind's Tulsa laboratories said, "The oxygenated compounds formed are a potential source of large quantities of valuable organic chemicals. These materials are useful in various fields as solvents, anti-freeze preparations, and raw materials for the manufacture of fine chemicals. Included are alcohols, ketones, organic acids and aldehydes, many of which have widespread commercial uses."

● **REDS TO HAVE GAS STORAGE UNIT.** Dresser Industries of Cleveland, Ohio, has signed a contract with Soviet authorities for construction of a $6,000,000 gas storage plant in Moscow, according to J. B. O'Connor, vice president.

Work on the plant will begin soon and will be completed by the Fall of 1949. A statement issued by Mr. O'Connor said: "This plant will liquefy 4,000,000 cubic feet of natural gas a day, the gas will be taken from the Moscow-Saratov pipe line and stored in liquid form, to be used for peak loads and standby service. The plant will provide storage for 1,610,000 cubic meters or 162,000,000 cubic feet of gas."

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THE Petroleum Engineer

MAY, 1947

Gulf leasing foreshadows much drilling

By **K. MARSHALL FAGIN,** *Field Editor*

A TIDAL wave of interest in the shallow coastal waters of the open Gulf of Mexico has mounted rapidly since August, 1945, when Magnolia Petroleum Company took 5-year commercial oil leases on 27 state-owned tracts covering about 129,000 acres in the Eugene Island area of St. Mary and Terrebonne parishes, Louisiana. One well[1], Magnolia's Block 58 No. 1 in the Eugene Island area, was drilled to a total depth of 12,874 ft and temporarily abandoned recently. A second well, Magnolia's Block 94 No. 1, is rigging up to drill, and locations for six other wells have been announced by the companies that have taken leases on more than 1,100,000 acres in the Gulf of Mexico along the Louisiana coast from the Sabine to the Mississippi.

EXCLUSIVE

More than $20,000,000 has probably been spent thus far in geophysical exploration and leasing in the shallow waterbottom areas of the Gulf of Mexico shown in Fig. 1, and the present rate of spending on these activities alone is more than $1,000,000 per month. This would be a nominal price to pay, however, for the discovery of a few 100,000,000-bbl oil fields like Vinton, Jennings, Paradis, or LaFitte, or for the discovery of a number of fields similar to the ones listed in Table 1 that have produced almost a billion barrels and will produce a total of about two billion barrels before they are abandoned.

Such fields are the visions of the oil men who are spending this money on the wide shelf of shallow ocean bed adjoining the State of Louisiana. The water covering this shelf is as shallow as 20 ft at some places 30 miles from land. At other places 50 miles from land the Gulf is less than 100 ft deep. Most of the exploratory work, however, is confined to the statutory 27-marine-mile strip owned by the State of Louisiana. This distance is equal to about 31.1 land miles.

● **Rough and inclement weather is serious obstacle.** The oilmens' worst enemy in converting this strip of shallow waterbottoms into a series of prolific oil fields is the weather with its high winds, high waves, and hurricanes. The depth of the water itself is no hindrance to the erection of well foundations and working platforms. Wells in Lake Maracaibo, Venezuela, have been drilled in deeper water as a matter of routine for many years. The water in the open Gulf is so much rougher most of the time, however, that it is difficult to keep the work and supply barges tied up and anchored securely to the well platforms.

Although several novel rig designs have been proposed for drilling on submarine locations, it is believed reasonable to anticipate that most of the companies will continue to construct platforms large enough to accommodate all the well-drilling equipment and supplies and sturdy enough to withstand violent hurricane winds and waves. As soon as a large field is discovered or the wildcat drilling rate increases due to lease expirations or other causes, a few of the companies may be expected to construct and experiment with drilling rigs especially designed for continuous use in the open Gulf in all kinds of weather. Considerable drilling expense could certainly be saved by the construction of a mobile, self-contained drilling rig, when the drilling obligations are sufficient to warrant the initial capital costs.

● **Feasibility of drilling in the Gulf.** Although about 5,000,000 bbl of oil had been discovered in 1938 by the Superior Oil Company in the Creole field by drilling nine wells from a platform in the open Gulf about a mile off the coast of Cameron Parish, Louisiana, few people gave much serious attention to the feasibility of drilling for oil in the open Gulf of Mexico. Petroleum geologists and many other oil men had suggested the possibility of finding oil fields on continental shelves, particularly along the shores of the Gulf of Mexico, but all of them had discounted this province as being outside the realm of commercial feasibility. Some considered the natural hazards of open water work in this region too much of an obstacle, but many others thought the water was too deep.

Geological and geophysical work in the open Gulf of Mexico began as early as 1928. The first leases were taken by Ed F. Simms, The Louisiana Land and Exploration Company, and the Texas Company. Amerada, Gulf, and Superior are among the companies that did con-

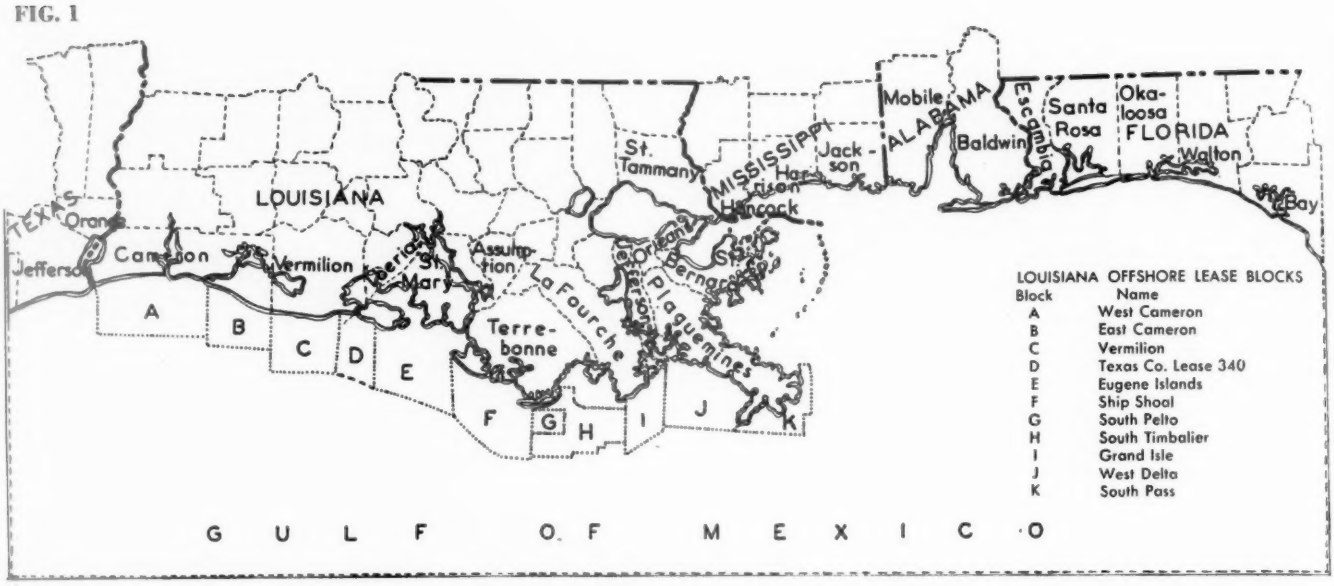
Results of last lease sale

The State of Louisiana Mineral Board awarded oil and gas leases on an additional 194,751 acres in the Vermilion, Eugene Island, and West Delta areas at its last sale on May 6, 1947, at Baton Rouge. These leases brought a total cash bonus of $1,379,182.94, or a little more than $7 per acre, for the first year.

The State of Louisiana has now leased about 1,372,421 acres in the open Gulf of Mexico for cash bonuses amounting to $9,554,764.32. Bids on tracts in the East Cameron and West Cameron areas will be received on June 10, 1947, as errors were discovered in the descriptions of the areas in the advertisements for the May 6 sale. Table 6 contains the detailed results of the May 6 lease sale.

[1] A description of this well may be found in the article "Magnolia Drills for Oil in Gulf of Mexico," by K. Marshall Fagin in the November, 1946 issue of *The Petroleum Engineer* pages 82 to 94, inclusive.

FIG. 1



siderable work in this province before the current wave of exploration and leasing.

The present wave of activity began in 1943 and stems from the idea that it is feasible to spend large sums of money to develop fields in this shallow water area provided as many barrels of oil can be found in structures in this area as have been found in a similar area along the adjacent coastal plain.

● **Geophysical exploration begun in 1944.** A Magnolia geophysical crew was equipped for open water work and embarked on its initial explorations in August, 1944. A Superior Oil Company crew had been equipped earlier, however, and had begun exploring in May, 1944. Most of the other companies believed these offshore ventures to be years in advance of economic feasibility for open water drilling. By the summer of 1946, however, most of the large companies had made plans for exploring, leasing, and drilling in this area. Ten to 25 geophysical crews have been engaged in exploration since that time. Table 2 reflects this rapid growth of interest in the Louisiana portion of the Gulf.

Although exploration and drilling in the shallow waterbottoms of the Gulf from the mouth of the Sabine to the mouth of the Mississippi may be expected to yield about 50 oil and gas fields with one to two billion barrels of recoverable oil, an equal or greater amount may be discovered under the shallow ocean beds adjoining Texas, Mississippi, Alabama, and Florida. The Texas portion of this province is the most promising of these other areas at the present time.

● **Louisiana leasing methods are attractive.** The Louisiana portion of this province is more attractive to the oil companies at this time, however, than the portions adjacent to other states. This is largely because of the attractive leasing methods of the Louisiana State Mineral Board.

Fig. 2 is an example of the way the areas are advertised for sealed bids. An area such as this is offered for lease by the State Mineral Board whenever a substantial oil company requests that it be offered. The company that makes the first request for the leasing of an area is, therefore, one that has spent considerable money in exploring the area and knows which tracts contain favorable structures. The company prepares the map of the area and divides it into blocks or tracts of 5000 acres or less. The state checks the engineering accuracy of the map, and after advertising the area for the required days, the sealed bids for the tracts are opened. The leases are awarded upon completion of contracts.

The expedient manner in which leasing is done and the large size of the lease tracts makes it difficult and very expensive for other companies to select the tract or tracts that contain favorable structure and bid enough to get it unless they explored the area before it was offered for lease. Thus, the companies that spend money exploring an area before others do it can usually camouflage their structural discoveries and win the leases by high bids on the right tracts. Companies that enter the bidding blindly will probably obtain tracts without pronounced structure.

In addition to favoring the companies that invest in exploration work, the system seems to be enriching the Louisiana state treasury as shown in Table 3 by the amount of money collected in cash bonuses for 1,177,670 acres of leases in the nine areas offered for lease since August, 1945. The East Cameron area will not be offered until June 10, so it is not included in this tabulation. Area D on Fig. 1, The Texas Company's Lease No. 340, is likewise not included.

● **Twenty-five per cent of areas offered have been leased.** About 25 per cent of the 4,440,000 acres (see Table 4) offered for lease in the nine areas tabulated in Table 3 has been leased. Some of these areas have been offered at two separate times, and several are being

TABLE 1. Importance of the lower Louisiana Gulf Coast as an oil producing area.

Parish	Main fields within 45 miles of the coastline	Production, MM bbl	
		Cumulative	Estimated ultimate recovery
Calcasieu	Edgerly, English Bayou-Gillis, Iowa, Lockport, Sulphurmines, and Vinton	185	260
Cameron	Black Bayou, Cameron Meadows, Chalkley, Grand Lake, Hackberry, East Hackberry, and Sweet Lake	110	160
Acadia	Jennings	96	115
Vermilion	East White Lake, Erath, Gueydan, and West Gueydan	40	110
Iberia	Avery Island, and New Iberia	41	150
St. Charles	Lake Salvador, and Paradis	29	160
St. Mary	Bateman Lake, Bayou Sale, Charenton, Horseshoe Bayou, Jeanerette, and West Cote Blanche Bay	52	200
Terrebonne	Bayou St. Elaine, Caillou Island, Dog Lake, Gibson, Lake Barre, and Lake Pelto	93	165
La Fourche	Chacahoula, Delta Farms, Golden Meadows, Lake Long, Leeville, and Valentine	84	200
Jefferson	LaFitte	50	125
Plaquemines	Garden Island, Grand Bay, Lake Washington, Potash, Quarantine Bay, Venice, and West Bay	82	215
	Total	862	1860

TABLE 2. Geophysical activity in the Louisiana portion of the Gulf of Mexico.

Year	Estimated crew months* Reflection	Refraction	Gravity	Total	Estimated total cost†
1944	4	2	..	6	$ 200,000
1945	24	6	..	30	1,000,000
1946	90	60	10	160	5,000,000
1947‡	150	80	20	250	7,500,000

*Less than half this time is spent on location, because of inclement weather.

†Boat rentals amount to as much as $600 or more per crew per day.

‡Estimated for the entire year.

FIG. 2

NOTICE OF PUBLICATION
State of Louisiana • State Mineral Board
Baton Rouge, Louisiana

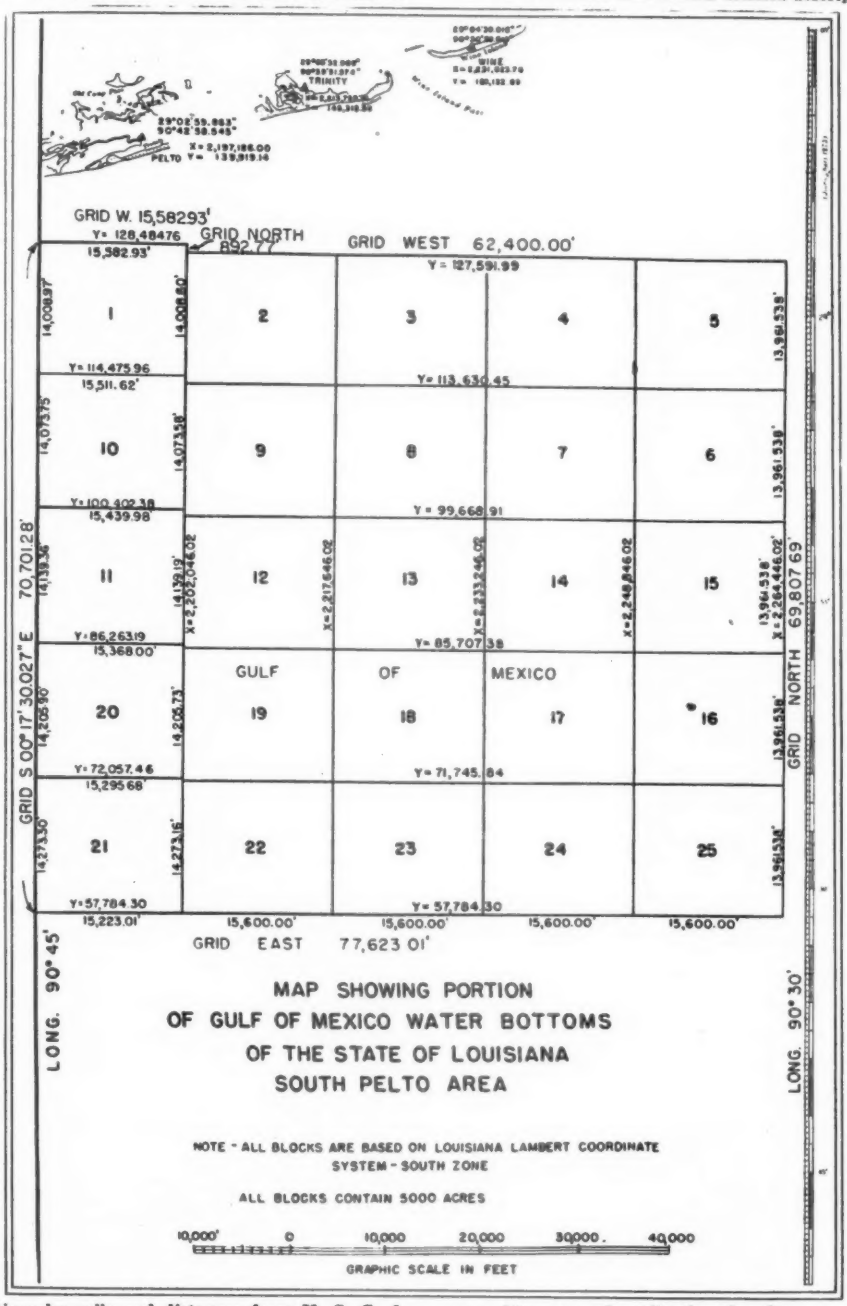
By virtue of, and in conformity with the provisions of Act 93 of the Regular Session of 1936, as amended, sealed bids will be received at the office of the State Mineral Board, State Capitol, Baton Rouge on or before the 13th day of August, 1946, at Ten (10) o'clock, A.M., for the lease of the sulphur, potash, oil, gas and/or other liquid or gaseous hydro-carbon mineral rights in and to the following described tracts, to-wit:

Tracts 1074 to 1098, inclusive, also being Blocks 1 to 25 inclusive (numbered consecutively beginning with Tract 1074), each containing not more than five thousand (5,000) acres and together constituting all the beds and bottoms of the Gulf of Mexico and other lands belonging to the State of Louisiana and contained within the total area in Terrebonne Parish, described as follows:

Beginning at the Northeast corner of Block No. 1 whose Lambert Coordinates are X = 2,202,046.02, Y = 128,484.76, same being Grid South 11,434.38 ft and Grid East 4,860.02 ft from U. S. C. & G. S. Triangulation Station "PELTO" whose Geographic position is Latitude 29°02'59.863", Longitude 90°42'58.545" and whose Lambert Coordinates are X = 2,197,186.00, Y = 139,919.14; Thence Grid West 15,582.93 ft to Meridian 90°45' West the Northwest corner of Block No. 1; Thence Grid S 00°17'30,027" E. 70,701.28 ft to the Southwest corner of Block 21; Thence Grid East 77,623.01 ft to the Southeast corner of Block No. 25; Thence Grid North 69,807.69 ft to the Northeast corner of Block No. 5; Thence Grid West 62,400.00 ft to the Northwest corner of Block No. 2 on the East line of Block No. 1; Thence Grid North 892.77 ft to the place of beginning.

Said tracts being also shown and located by Block numbers on plat on file in the State Land Office and Department of Public Works Office at Baton Rouge, Louisiana, hereafter known as South Pelto Area, of which the accompanying plat is an exact copy:

Bids for each tract shall refer to the tract and block numbers and contain detailed descriptions by calls and distances from U. S. C. & G. S. Triangulation Station "Pelto" as shown on said plat and in accordance with Louisiana Coordinate System, adopted by act 226 of 1944. Such detailed descriptions and copies of plat will be furnished to any interested party by the State Land Office or State Engineer's Office on written or oral application therefor.


GRID W. 15,582.93'
Y= 128,484.76
GRID NORTH 892.77'
GRID WEST 62,400.00'
Y= 127,591.99
GRID S 00° 17' 30.027" E. 70,701.28'
GRID NORTH 69,807.69'
LONG. 90° 45'
LONG. 90° 30'
GULF OF MEXICO
GRID EAST 77,623.01'
MAP SHOWING PORTION
OF GULF OF MEXICO WATER BOTTOMS
OF THE STATE OF LOUISIANA
SOUTH PELTO AREA
NOTE - ALL BLOCKS ARE BASED ON LOUISIANA LAMBERT COORDINATE SYSTEM - SOUTH ZONE
ALL BLOCKS CONTAIN 5000 ACRES
10,000' 0 10,000 20,000 30,000 40,000
GRAPHIC SCALE IN FEET

All bids to offer a cash bonus for lease with a primary term which shall not exceed five (5) years. Minimum royalties shall be one-eighth (⅛) of all oil produced and saved; one-eighth (⅛) of all gas produced and saved or utilized; seventy-five (75) cents for each long ton of sulphur produced and saved; ten (10) cents per ton for all potash produced and saved; one-eighth (⅛) of all other liquid or gaseous hydro-carbon minerals produced and saved.

Lessee must agree to drill within one (1) year, or to pay rental for the right to defer drilling for a period which CANNOT EXCEED five (5) years from date of contract, and to drill offset wells if necessary to protect the State's interests and not to sublease unless agreed to by the State Mineral Board.

The Lessee shall have the right to enter into pooling or unitization agreements with respect to development of the leased premises subject to approval of the State Mineral Board.

Certified check, payable to the Register, State Land Office, for the full amount of the cash bonus shall accompany and be deposited with each bid and no bid or deposit may be thereafter withdrawn or cancelled; and the cash bonus thus deposited shall be forfeited to the State by the successful bidder in the event said bidder does not enter into written contract within ten (10) days after the written lease is submitted to him for execution.

The State Mineral Board reserves the right to reject any and all bids and to grant a lease on any portion of the tracts advertised for a price not less than proportionate to the best bid offered for the lease on the entire tract.

submitted again for sealed bids.

The cash bonuses for the first 1,177,670 acres leased amounted to $8,175,581, or an average of about $7 per acre. The lowest bid accepted by the State Mineral Board was $2 per acre, and the highest bid for a 5000-acre tract was $165,000, or $33 per acre.

The leases are for a primary term of five years from date of execution of contract. Drilling can be delayed from year to year during this term by payment of a delay rental equal to one-half the amount paid as the initial cash bonus. Minimum royalty to the state is the usual one-eighth of the total production.

● **High rentals should stimulate drilling.** With only 5-year primary term leases and delay rental payments of one-half of the initial cash bonus, it is obvious that early exploratory drilling of these leases will enable the companies to cash in on oil production or condemn and drop their leases.

Although drilling may be stimulated by these terms, it is obvious that 10-year commercial leases with a nominal annual rental would keep leases in force on more of the doubtful prospects. This would suit many of the companies better, and might give the State more money in annual rentals.

It will cost the company that paid $165,000 for a 5000-acre tract one-half that amount, or $82,500 per year, to keep that lease. It will probably drill as soon as possible rather than pay so much money each year. The average delay rental for all leases now is about $3.50 an acre, or a total of $4,000,000 a year.

Magnolia's Eugene Island area well No. 1 on block 58 is the only well drilled so far on any of the leases. It was situated on a platform in 16 ft of water about five miles from land. It was drilled to a total depth of 12,874 ft; plugged back; sidetracked directionally to a total depth of 11,714 ft; and temporarily abandoned.

● **Magnolia rigging up to drill second well.** Magnolia's second well on one of these leases will be its Eugene Island Block 94 No. 1, situated on a platform in 22 ft of water about 25 miles from the nearest land. This well is being rigged up, and other tests are being planned by Magnolia. Berwick and Morgan City,

TABLE 3. Louisiana's Gulf of Mexico lease block data. *(Does not include leases awarded on May 6, 1947)*

Area	Name	The California Co.		Continental Oil Co.*		Humble Oil & Refining		Kerr-McGee**		Magnolia Petroleum Co.		Pan-American-Seaboard	
		Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres
A	West Cameron							$ 95,000.00	5,000	$ 12,500.00	2,500		
C	Vermilion									874,812.24	144,602†	$ 50,000.00	25,000
E	Eugene Island							317,500.00	40,000	377,500.00	90,000		
F	Ship Shoal									60,000.00	15,000	11,250.00	5,000
G	South Pelto					$ 172,994.00	12,200					63,936.00	28,416
H	South Timbalier	$ 6,250.00	2,500	$ 33,600.00	14,296	954,627.00	73,860						
I	Grand Isle	21,250.00	7,270	339,424.00	92,500	600,000.00	40,000						
J	West Delta	479,069.00	62,127	347,444.00	118,286	870,000.00	32,500						
K	South Pass												
9	Total	$506,569.00	71,897	$720,468.00	225,082	$2,597,621.00	158,560	$412,500.00	45,000	$1,324,812.24	252,102†	$125,186.00	58,416

*Atlantic, Cities Service, and Tide Water are interested in the Continental leases.
†39,421 acres of these leases were dropped before the first rental payments.
**Phillips Petroleum Company and Stanolind Oil and Gas Company are interested in the Kerr-McGee leases.

Area	Name	The Pure Oil Co.		Shell Oil Co.		Stanolind Oil & Gas Co.		Superior Oil Co.		The Texas Co.		All companies	
		Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres	Initial lease cost	Lease acres
A	West Cameron					$ 21,675.00	4,335	$107,000.00	20,000			$ 128,675.00	24,335
C	Vermilion	$295,200.00	42,500			529,901.00	57,204	194,265.00	9,000			1,126,866.00	116,204
E	Eugene Island	223,025.00	40,000							$167,700.00	20,000	1,315,537.24	229,602
F	Ship Shoal					186,150.00	30,000					881,150.00	160,000
G	South Pelto					10,550.00	5,000					254,794.00	37,200
H	South Timbalier					35,296.00	8,772			72,291.00	5,214	1,166,000.00	133,058
I	Grand Isle			$ 50,560.00	15,000	27,746.14	5,000					1,038,920.14	159,770
J	West Delta											1,696,513.00	212,913
K	South Pass			408,279.00	94,725					158,847.00	9,863	567,126.00	104,588
	Total	$518,225.00	82,500	$458,779.00	109,725	$811,318.14	110,311	$301.265.00	29,000	$398,838.00	35,077	$8,175,581.38	1,177,670

Louisiana, serve as the main base for these operations.

Humble Oil and Refining Company is preparing to drill two wells off Grand Isle in 48 ft of water. Humble's base of operations is Harvey, Louisiana. Kerr-McGee is preparing to drill two wells in the west central part of the Ship Shoal area, which is southeast of Magnolia's Block 58 test. Phillips Petroleum Company and Stanolind are interested with Kerr-McGee in these wells.

Stanolind is planning to drill a well about 10 miles east of the Kerr-McGee wells in the Ship Shoal area, and the Superior Oil Company is planning to drill a well about 15 miles offshore in the Vermilion area. Superior has its shore base for this area at Abbeville. Kerr-McGee and Stanolind operate in the Ship Shoal area from Berwick or Morgan City, Louisiana.

TABLE 4. Louisiana Gulf areas offered for lease.

Areas	Name	Approximate total acres
A	West Cameron	840,000
B	East Cameron*	340,000
C	Vermilion	520,000
E	Eugene Island	650,000
F	Ship Shoal	770,000
G	South Pelto	125,000
H	South Timbalier	530,000
I	Grand Isle	350,000
J	West Delta	445,000
K	South Pass	210,000
	Total acres	4,780,000

*First bids to be received June 10, 1947.

TABLE 5. Creole field, Cameron Parish, Louisiana.

Year	—Crude oil production, bbl— During year	Cumulative	No. of wells
1938	156,400	156,400	3
1939	574,800	731,200	9
1940	579,100	1,310,300	9
1941	395,100	1,705,400	8
1942	262,700	1,968,100	8
1943	220,500	2,188,500	8
1944	181,800	2,372,300	7
1945	152,600	2,524,900	7
1946	133,100	2,658,000	7

Production is obtained from three Miocene sands between 5100 and 6650 ft; average gravity of the crude oil is 34° API. About 350 MMCF of gas was produced in 1946, and about 2400 MMCF has been produced since the beginning. Deepest test was drilled to 9895-ft total depth in the Miocene.

● **Drilling costs are prohibitively high.** The cost of drilling these open water wildcat tests at the present time is tremendous and serves as a real brake on drilling activity. The platforms alone cost from $200,000 to $400,000, depending upon the depth of the water, the design of the platform, and the depth of the well to be drilled. Then the actual drilling costs are much higher than for land-based operations, because of the additional transportation and quartering costs for the crews and supplies.

Here, as in the geophysical and surveying work, the hazards of rough and stormy weather may delay the drilling work and double or triple the usual costs. A 10,000-ft well might cost from $400,000 to $1,000,000, and deeper wells or multiple directional wells from one platform might entail the expenditure of as much as $3,000,000. It is evident that intensive study and much deliberation will precede an appropriation of this magnitude, but the prospect of finding a Paradis or a LaFitte is enough to encourage most of the large companies to make the necessary drilling appropriations and assume the heavy risks involved.

A few of the large companies appear to be waiting for a large field to be discovered before risking any money on exploration, leasing, or drilling. It is possible a number of wells will be drilled before the first rich oil pool is discovered. It is also possible that leases on many of the current prospects will be abandoned without conclusive testing, but it is a foregone conclusion in the minds of many oil men that millions of barrels of oil will be found in the structures that have been discovered to the present time.

TABLE 6. Leases awarded by the Louisiana State Mineral Board on May 6, 1947 (not included in Table 3).

Company	Bonus	Acres
Vermilion area (C)		
Continental et al	$ 151,570.00	67,565
Kerr-McGee	47,051.00	5,000
Pan American-Seaboard	44,400.00	20,000
Pure Oil Company	51,400.00	10,000
Stanolind Oil & Gas	220,296.78	10,474
Superior Oil Company	357,650.00	20,000
The Texas Company	15,550.00	4,549
Total	$ 887,917.78	137,588
Eugene Island area (E)		
Pure Oil Company	$ 9,100.00	2,500
Pan American-Seaboard	11,100.00	2,500
The Texas Company	221,900.00	25,000
Total	$ 242,100.00	30,000
West Delta area (J)		
California Company	$ 194,450.00	13,315
Continental et al	15,500.00	5,000
Humble Oil & Refining	9,406.80	3,015
Shell Oil Company	29,808.36	5,833
Total	$ 249,165.16	27,163
Total awards on May 6th	$1,379,182.94	194,751

Here was discovered by the Superior Oil Company in March, 1938, when its State No. 1 was completed for 215 bbl of 34-deg API gravity oil through ¼-in. choke with tubing pressure of 800 psig. Production was from perforations between 5110 and 5130 ft. Estimates of the ultimate recovery of this field range from 4 to 5 million bbl. ★ ★ ★

● **Creole field is drilled from a platform.** The only producing field that has been found in the open waters of the Gulf is the Creole field, which is about one mile off the shore of Cameron Parish and about eight miles east of the town of Cameron. Table 5 shows the annual and cumulative oil production from this field. All the wells are drilled from a large platform. Two of the directionally drilled wells were dry holes. Seven of the nine oil wells are still flowing.

Creole was discovered by the Superior Oil Company in March, 1938, when its State No. 1 was completed for 215 bbl of 34-deg API gravity oil through ¼-in. choke with tubing pressure of 800 psig. Production was from perforations between 5110 and 5130 ft. Estimates of the ultimate recovery of this field range from 4 to 5 million bbl. ★ ★ ★

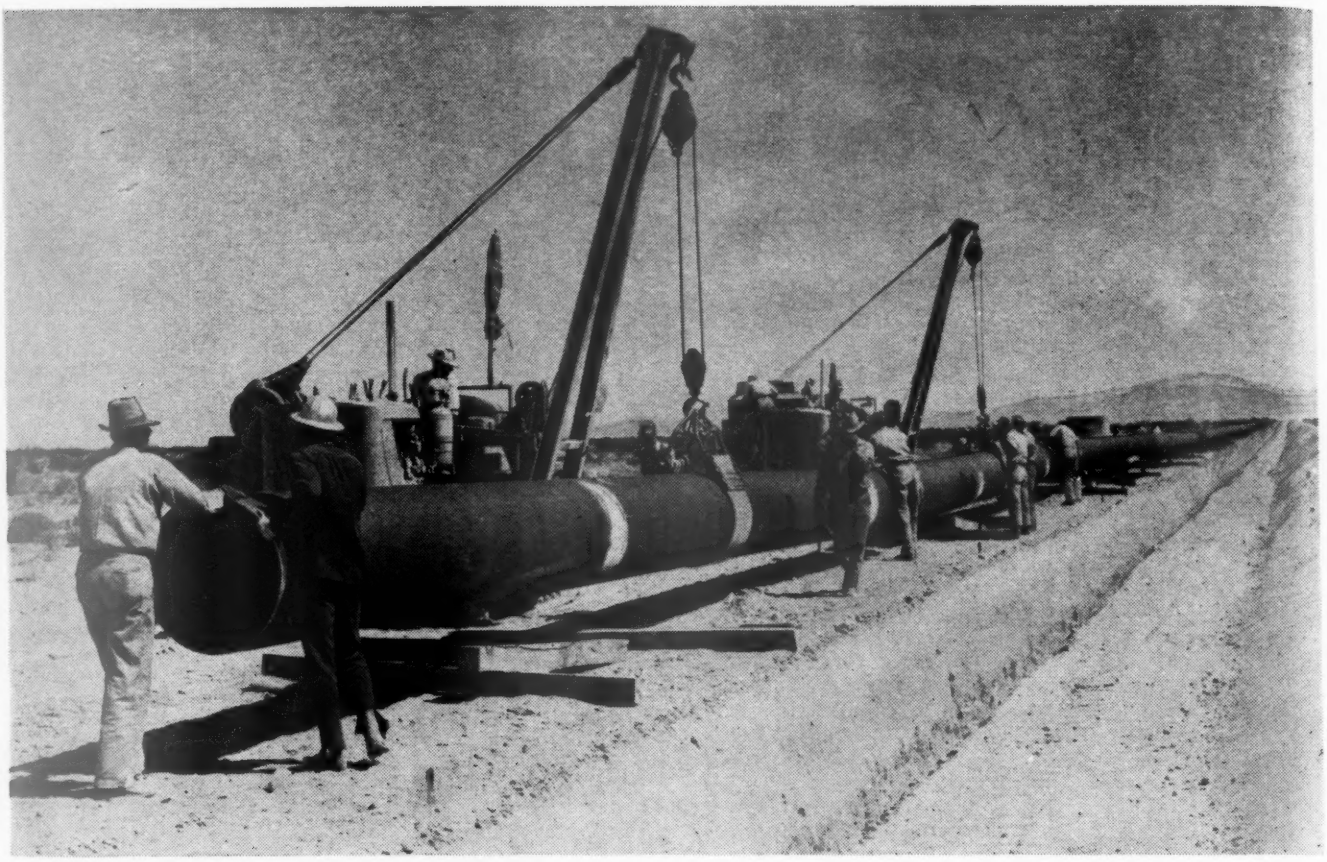
Stringing the 30-in pipe for the California section of the line. About 168 miles of this large-diameter pipe had been fabricated by April 29.

Progress report on "Biggest Inch" line

EARLY this year work began on construction of a gigantic pipe line project—the laying of 1202 miles of gas line, ranging in diameter from 24 in. to 30 in., from West Texas to Southern California. This is a joint program of the El Paso Natural Gas Company and the Southern California Gas Company and Southern Counties Gas Company of California. The first gas is expected to be sent through the line late this year.

El Paso Natural's part of the project is 737 miles of 26-in pipe line from Eunice, Lea County, New Mexico, to the California-Arizona state line near Blythe, Arizona, and a 251-mile extension of 24-in transmission line from Dumas, Texas, to Eunice. Being constructed for the two California companies are 214 miles of 30-in pipe line. The photographs on this and the succeeding page were taken of work on the latter project, which was first to get started.

Initial step in construction of a pipe line is the making of surveys to determine its route. In the picture at the bottom of the page on the right George Norman, engineer in charge of preliminary surveys for Southern Counties Gas Company, is seen at the transit. The picture was taken on a section of the right-of-way near the town of Desert Center, California.



In the photograph at the top of the page the pipe crew is lining-up a 60-ft joint for welding. The trench into which the pipe will be lowered can be seen in the foreground. Approximately 64 miles had been trenched by April 29, 59¼ miles had been welded, 52½ miles lowered in, and 50 miles backfilled. As of the same date, 162 miles of the right-of-way had been graded, 160½ miles of pipe strung, and approximately 168 miles of the 30-in. pipe fabricated.

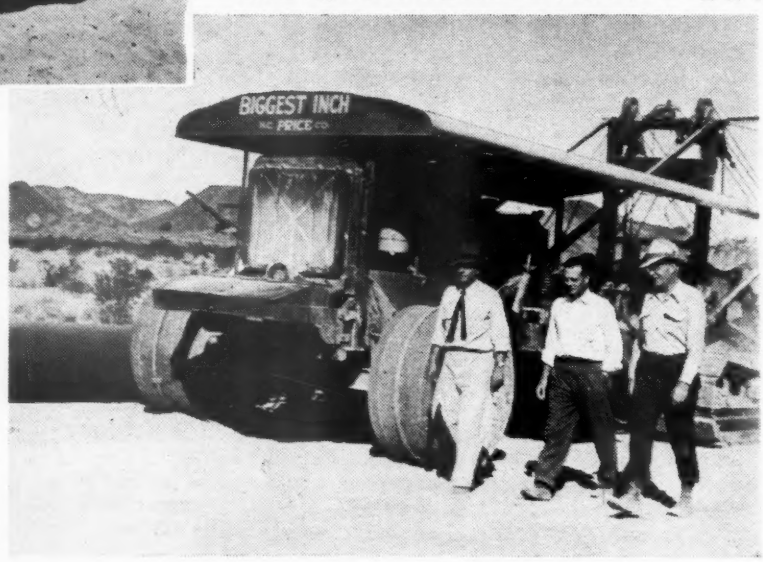
The picture immediately above shows a pipe crew lining up the ends of the pipe for welding. A new type interior clamp is being used for the purpose.

In the lower right-hand corner of the page are seen H. C. Price, president, and J. P. Neill, vice president, of H. C. Price Company (contractors), and William Pipkin, chief inspector for Southern California Gas Company, making a personal survey of progress.

Work began on the California section with one spread. On April 19 a second spread was added near Banning. C. D. Gamble is the inspector foreman. Inspector foreman on the first spread is William Pipkin, mentioned. Foreman on the section for H. C. Price Company is C. F. Lenoir, and M. J. Binckley is field engineer for the California companies.

The West Texas-California pipe-line system is planned for three progressive stages of construction and operation, with gas deliveries by El Paso Natural to the California companies at the California-Arizona border scheduled to begin this year and continue for 30 years. The maximum contracted volumes to be delivered by El Paso are 125,000,000 cu ft a day the first year, 175,000,000 cu ft a day the second, third, and fourth years, and 305,000,000 cu ft a day the fifth and succeeding years.

El Paso's system, at its ultimate capacity, is estimated to cost $53,800,000. Total cost of the California segment is estimated at $16,225,000. ★ ★ ★



Intercommunication system used on West Texas rig

By **WILLIAM J. DAVIS**

THROUGH a simple application of modern electronics developed by Ray O. Howard, Midland, Texas, it is now possible for drillers to converse with their derrick men in a normal tone of voice, despite the usual engine and machinery noise common to most drilling rigs.

EXCLUSIVE

Installed recently on one of the world's largest rigs at Monahans, Texas, the intercommunication system is proving its value daily during normal operations of the drilling rig. Drillers and roughnecks alike are enthusiastic over the simplicity of the system that saves them many steps, puts the driller in instant contact with his men at critical points of operation, and insures instant and correct response to orders during emergencies.

In its basic form, the unit consists of a master station installed at the driller's position with pushbutton connection to the monkey-board where a sub-station speaker is placed. The driller can be heard at any time by the derrickman above the roar of machinery whenever the driller addresses his station. The derrickman in turn can talk to the driller by pressing a button and using the speaker as a microphone.

The basic unit of two stations with all necessary wire and connections weighs less than 100 lb.

So versatile is the unit that it can operate on a-c or d-c current from rig auxiliary power plants or from outside utility connections. With rig voltages known beforehand, a simple adjustment of the power pack will adapt it to any given voltage duty. The basic unit current consumption is reported to be negligible when the unit is on continuous stand-by service and little more when in use.

The driller operates the master station, which is in direct connection with all the substations installed on the rig. The master station is placed conveniently at the drawworks near the driller's operating controls.

Man who most benefits from the system is the derrick man. His speaker puts him in instant communication with the driller for instructions. A pushbutton allows him to reply to driller through the same speaker.

Additional sub-stations are in use on this particular rig at such strategic points as the engine room and below the derrick floor near the cellar connections. Others are planned at the pumps, the dog house, and possibly the cement house.

The unit is of such a design that two or more rigs within one location of each other may be connected together for intercommunication by laying telephone wire to the rigs in question and adding more sub-stations.

In areas of intense noise, such as the engine room, it was found advisable to install micro sub-stations to filter out engine noise in replying to the master station situated at the driller's position. The large speaker-microphone combination is not capable of separating engine noise and voice.

In using the micro sub-station, the operator receives his instructions over the usual loud speaker. If he wishes to reply for any reason, he can lift a small directional microphone from its hook near the speaker and address his remarks at close range. The action of lifting the microphone from its hook automatically cuts off the regular speaker from the circuit.

The advantage in instant communication over and above the noisy machinery of a rig running full blast can be well appreciated by one who has attempted by voice and arm signals to convey instructions of even a simple nature in these surroundings. From the standpoint of safety the use of an intercommunication system on a drilling rig has many promising possibilities. ★ ★ ★

Engine room speaker is on long cord so it may be moved about. A micro sub-station has been added to this location to allow the engine room workman to reply to driller without engine room interference. Roughnecks have found it convenient to move speaker and cord to various locations in the engine house close to their work. This insures prompt exchange of orders and reports of progress.

Instructions to roughnecks in the cellar, where important connections and valves are located, can be given instantly in case of emergency.

It has been found that the unit is especially valuable during the landing of casing strings. Transmission of clear signals to and from the driller during this operation has increased safe working conditions very much.

Economical alignment for pipe lines

By **CHARLES S. LARKEY,** Sinclair Prairie Oil Company

THE AUTHOR

Charles S. Larkey, a native of Oklahoma, has been with the Sinclair Prairie Oil Company since 1919. His present position is head of the department of valuation and statistics. He spent a number of years with the pipe line division of his company before being transferred to his present position. He is a registered professional engineer in Oklahoma.

☆ ☆ ☆

THE problem of economic alignment of pipe to connect three points not in a straight line is often encountered by pipe line engineers. Referring to Fig. 1, such a problem is illustrated where points A, B, and C are to be connected. Clearly, a point P exists so that the common connection of three lines will use the minimum amount of pipe.

EXCLUSIVE

The problem has been attacked from the standpoint of placing P on one of the altitudes of the triangle ABC*. Although this method gives an approximate solution, a more economical location may be found.

Considering the point P in Fig. 1 as in static equilibrium, and that the three pipe lines each has the same cost per unit length, the position of P is determined when such lines make equal angles with each other, that is, referring to Fig. 1, when:

$P = P' = P'' = 120°$.

This relationship provides the conditions for the solution of the problem presented in Fig. 1, in which the following data are given: AD = 17.50, DB = 2.5, and CD = 10.

From these relationships, the "three-point problem" may be solved as follows:

$\tan A = 10/17.50 = 0.571429 = \tan 29° 44.69'$,

$\text{sum} = P + P' + A = 120° + 120° + 29° 44.69' = 269° 44.69'$,

$S = 180° - \frac{1}{2}\,\text{sum} = 45° 7.65'$,

$\tan Z = \dfrac{c \sin 120°}{b \sin 120°} = \dfrac{c}{b} = .992278 = \tan 44° 46.68'$,

$\tan S \cot (Z + 45°) = \tan 45° 7.65' \cot 89° 46.68' = 0.003891 = \tan 0° 13.38'$

$\varepsilon = 0° 13.38'$,

*Peyton Bryan, in *The Petroleum Engineer*, October, 1946, p. 212.

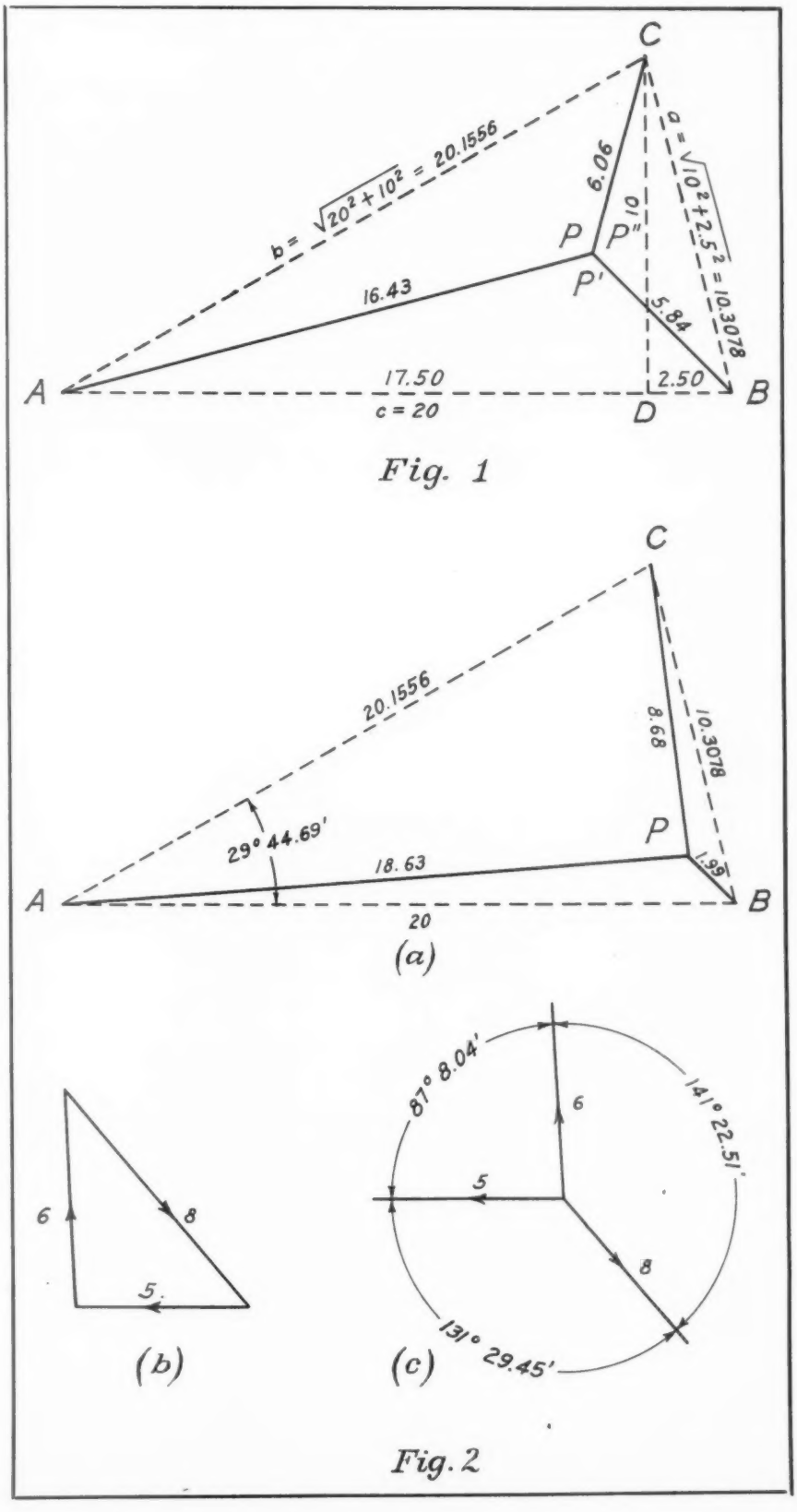
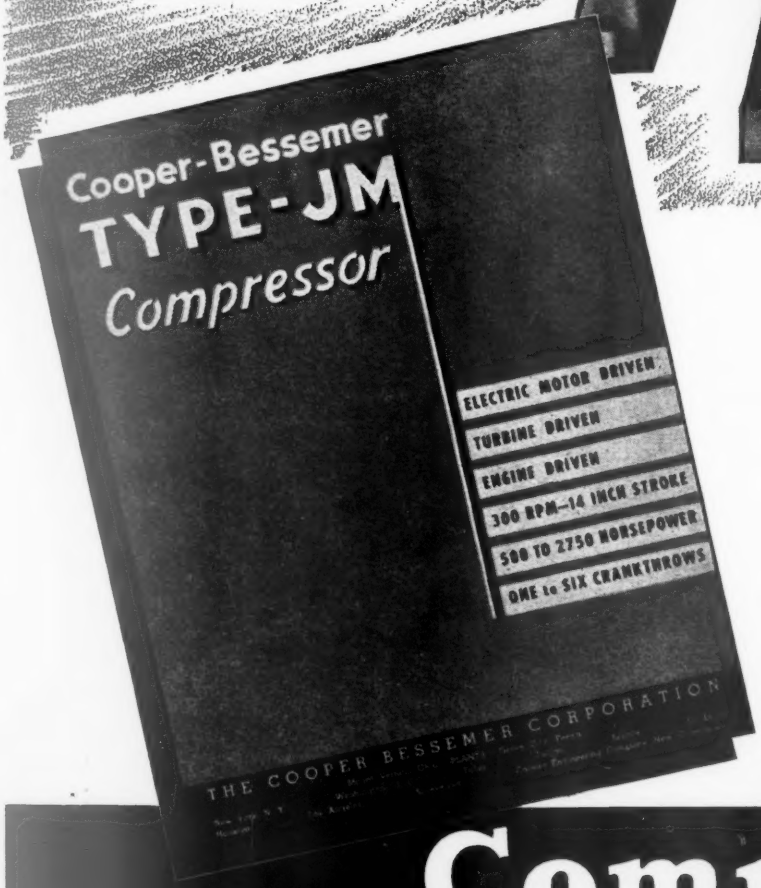


Fig. 1

Fig. 2

Introducing a



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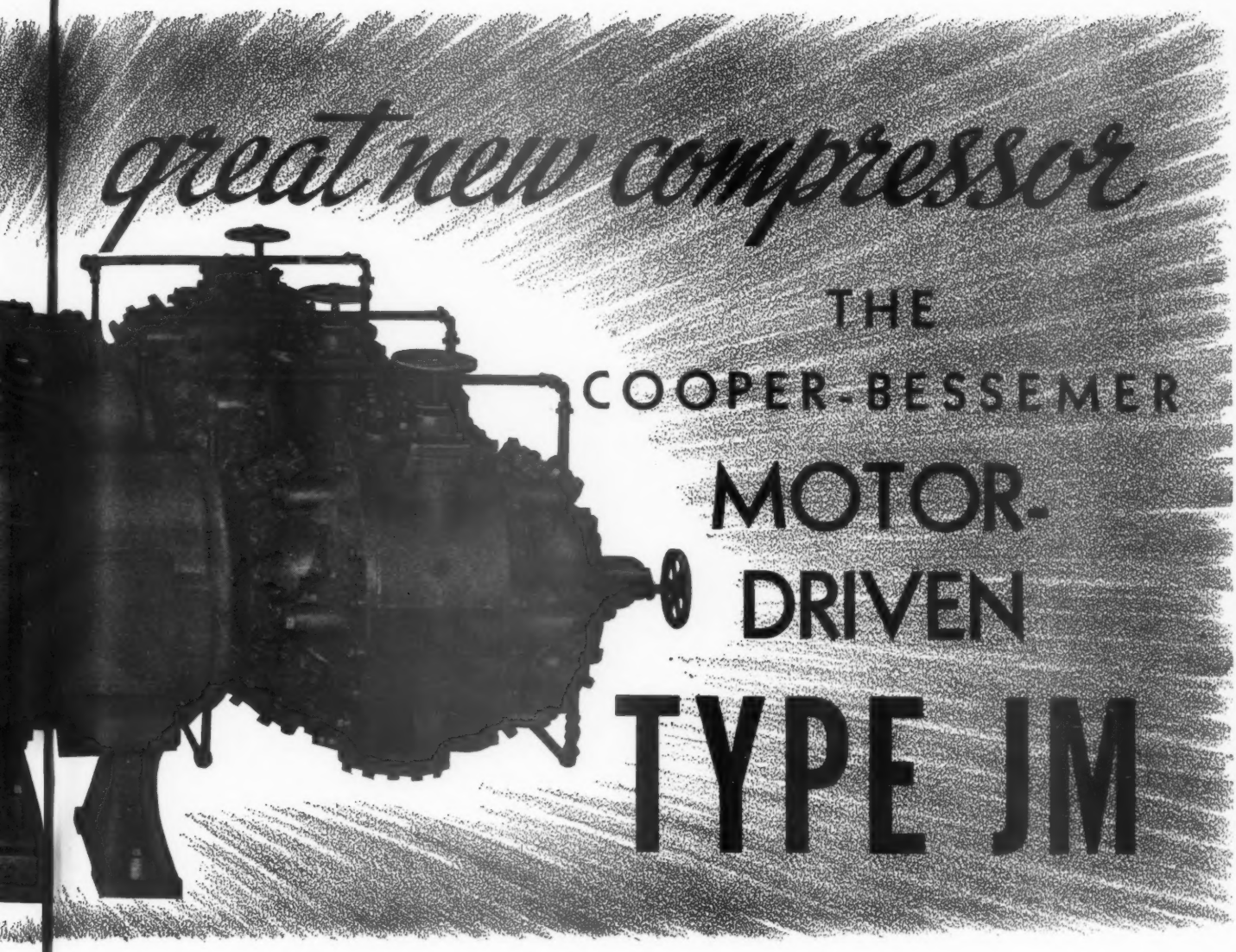

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$< ABP = S + \varepsilon = 45° 21.03'$,
$< ACP = S - \varepsilon = 44° 54.27'$

$$AP = \frac{20 \sin 45° 21.03'}{\sin 120°} = 16.43,$$

$$BP = \frac{20 \sin 14° 38.96'}{\sin 120°} = 5.84,$$

$$CP = \frac{20.1556 \sin 15° 5.73'}{\sin 120°} = 6.06,$$

Total length of pipe 28.33

It frequently happens, however, that the three branches of the common connection are of different sizes, hence, economy is determined by the relative costs per unit of length of each size.

Fig. 2(a) illustrates such a condition, where the relative position of A, B, and C are the same as in Fig. 1, with the added condition that the cost ratios of the lines are as follows: AP=5, CP=6, BP=8. To place P in static equilibrium, a force polygon such as Fig. 2(b) is drawn with the sides in the ratios of the relative costs. The force diagram, then, for static equilibrium will have its rays parallel to the sides of this triangle, as in Fig. 2(c).

The central angles may be easily calculated from the triangle (b), and the solution for the location of P be carried out as before.

Having already determined the value of angle A, we proceed as follows:

sum $= 131° 29.45' + 87° 8.04' + 29° 44.69' = 248° 22.18'$,

$S = 180° - \frac{1}{2}$ sum $= 55° 48.91'$,

$$\tan Z = \frac{20.1556 \sin 131° 29.45'}{20 \sin 87° 8.04'} = 0.755778 = \tan 37° 4.88',$$

$\tan S \cot (Z + 45°) = \tan 55° 48.91' \cot 82° 4.88' = 0.204788' = \tan \varepsilon$

$\varepsilon = 11° 34.41'$,
$< ACP = S + \varepsilon = 67° 23.34'$,
$< ABP = S - \varepsilon = 44° 14.52'$.

$$AP = \frac{20 \sin 44° 14.52'}{\sin 131° 29.45'} = 18.63,$$

$$BP = \frac{20 \sin 4° 16.03'}{\sin 131° 29.45'} = 1.99,$$

$$CP = \frac{20.1556 \sin 25° 28.66'}{\sin 87° 8.04'} = 8.63$$

When the required conditions are such that one of the angles of the triangle ABC exceeds the corresponding angle at P, it is readily apparent that P lies outside the triangle, hence, a continuous line through the vertex of such angle has the minimum length. Thus, in Fig. 1, if angle C should exceed 120°, the most economical alignment would be A-C-B.

The location of P from a practical standpoint is greatly facilitated by the use of a graphic solution instead of the method just described. This can be accomplished by drawing rays from a central point as in Fig. 2(c), and then superimposing thereon a tracing on which the points A, B, and C have been carefully plotted to scale. By shifting the tracing, the rays may be made to pass through their respective points and a trace of the required alignment made.

The graphic method is sufficiently accurate to recommend it in all instances except when extreme precision is demanded; and as there are usually other influencing factors such as terrain, availability of right-of-way, obstacles to be avoided, etc., the exact mathematical solution is seldom required. ★ ★ ★

P 090.

Causes of corrosion in high pressure boiler tubes

AN ANALYSIS of the causes of corrosion experienced with metals used for steam generating tubes and superheater tubes in high pressure boilers, and some recommendations of what can be done to overcome this problem, were presented recently in a paper delivered before the Louisville Congress of the Electro-Chemical Society by Paul M. Brister, staff engineer, and J. B. Romer, chief chemist, of The Babcock and Wilcox Company of New York.

For high temperature superheater tubes, the paper showed how temperature shock affects the rate of corrosion on the steam side and the gas side of the tube. "With proper selection of ferritic type chromium-molybdenum steel alloys, steam and flue gas corrosion is not troublesome for metal temperatures up to about 1200 F," the authors stated. "Stainless steels are satisfactory for temperatures somewhat above 1200 F. For structural members, such as hangars and supports, chromium-nickel steel alloys are preferred for elevated temperature service."

A type of corrosion that has been quite serious, although not prevalent, in carbon steel tubes in high pressure boilers was described by the authors. This corrosion appears in the form of intergranular disintegration of the metal adjacent to a pit that is filled with iron oxide. Usually deposits of metallic copper, and oxides of copper are present in the zone affected by corrosion, but the authors pointed out that metallic copper is often found in boilers that are not troubled by corrosion. It was stated that dissolved ammonia in the boiler feedwater can bring copper into the boiler, provided there are materials containing copper in the system with which the feedwater comes in contact.

In presenting their analysis of this type of corrosion, the authors discussed all conditions associated with the failures, and stated the principal relief from this corrosion has come from: (1) Eliminating or reducing as much as possible, the ammonia in the feedwater-steam system; (2) maintaining the boiler water at a satisfactory alkalinity or pH level; (3) reducing the dissolved oxygen in the feedwater to as near zero as possible, and (4) maintaining a small but positive excess of sulphite in the boiler water.

The paper points out that from the corrective steps that have alleviated this trouble, it would appear that copper and oxygen were the principal agents involved in this type of metal damage.

In the consideration of high temperature corrosion of superheater tubes, the authors discussed the general temperature conditions associated with high temperature superheaters, and pointed out that usually de-slaggers are used to keep the tubes free from ash or slag accumulations.

The high metal temperatures experienced with these superheaters are in the range where a reaction between iron and steam will occur, where air oxidation can be severe, and where the strength of ferritic type alloy steel is relatively low, because of the creep characteristics of steel at high temperatures, the authors pointed out that stress must be considered in discussing corrosion, for they are closely associated when failure occurs.

The paper discussed some of the most severe cases of steam corrosion in superheaters that have been experienced by the authors, who stated, "we believe that the chronology of events that led to failures can be established as follows:

1. A thin, tightly adherent, oxide deposit forms on both the steam side and the gas side of the tube wall.

2. The temperature shock of the relatively low temperature steam or steam and water from the de-slaggers causes cracking of the oxide due to the different thermal expansion characteristics of the oxide and the metal.

3. The surface exposed at the base of the cracks becomes oxidized.

4. This cycle is repeated many times.

5. The layer of oxide on the inside metal surface raises the metal temperature in the tube, thus increasing the oxidation rate.

6. Progressive oxidation from both the inside and outside of the tube wall reduces the thickness of the wall, and increases the stress.

7. The increased temperature reduces the strength of the metal, which together with the increased stress (item 6) causes accelerated creep of the metal.

8. The accelerated creep continues until failure occurs.

The authors concluded that chromium-molybdenum steel alloys containing from 2 per cent to 9 per cent chromium, and 0.5 to 1.0 per cent molybdenum when properly selected for the expected temperatures are very satisfactory for use with metal temperatures up to 1200 F. Above this temperature, it appears that the stabilized 18-8 stainless alloy is satisfactory, and indications are that this material will be more extensively used in the future with the higher steam temperatures. ★ ★ ★

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P 090.

Industry's public relations program enters new phase

With seven of its eleven districts already organized, the oil industry's public relations program has moved to its next phase: stimulating industry units to work in getting the story across to the public. More than 500 representatives of petroleum companies and trade associations have accepted membership on district committees, which eventually will include some 1000 persons from all segments of the industry.

Initial activity of the program was designed to spread understanding of the plan throughout the industry and to obtain the participation of all interests—producing, refining, transportation, and distribution.

As part of the first phase of the program, organizing committees met in each of the five districts set up in wartime by the Petroleum Administration for War. For purposes of the public relations program, two of these districts, PAW I, the Atlantic seaboard states, and PAW II, the Midwest, were each divided into four autonomous districts. PAW III, which will operate under one district committee, was divided into three areas, each of which will have its area committee. Kansas and Oklahoma, in PAW II, now comprise an area of District 3 under the public relations setup.

Following is a complete listing of districts in which committees will carry out details of the public relations program:

New England (Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, and Connecticut).

New York—New Jersey.

Middle Atlantic (Pennsylvania, Delaware, Maryland, West Virginia, and the District of Columbia).

Southeast (Virginia, North Carolina, South Carolina, Georgia, and Florida).

Ohio, Kentucky, and Tennessee.

Great Lakes States (Illinois, Michigan, Indiana, and Wisconsin).

Minnesota and the Dakotas.

Iowa, Missouri, and Nebraska.

Southwest—Eastern Gulf area (Alabama, Mississippi, Arkansas, and Louisiana); Texas-New Mexico area; Oklahoma-Kansas area.

Montana, Idaho, Wyoming, Utah, and Colorado.

California, Arizona, Nevada, Oregon, and Washington.

The public relations program has been presented at all meetings of organizing committees and at the seven organizational meetings of district committees. In addition, it has been described before gatherings of 28 trade associations and before 27 informational meetings of oil industry representatives. Altogether, the story of the program to win more friends for the industry and to stress the progressive nature of its activities has now been told at 67 meetings.

First steps in organizing committees for each of the 11 districts and for the three areas in District 3 have consisted of election of district and area officers, obtaining acceptances to serve on district committees, and establishing finance, speakers' and industry participation subcommittees to present the program to the more than 34,000 companies in the oil business and to hundreds of trade associations.

In New England, the district committee named R. R. Potts, of Socony-Vacuum Oil Company, as chairman, and John Birmingham, of the Independent Oil Men's Association of New England, as vice chairman. To date, 29 representatives of oil companies and trade associations have accepted membership on the district committee.

In the New York—New Jersey district, 61 acceptances have been received thus far.

Osmun Skinner, of the Van Dyne Oil Company, is chairman of the Middle Atlantic district, with R. D. Kizer, Shell Oil Company, as vice chairman. Fifty-one acceptances have been received.

All 19 oil men invited to serve on the district committee for Ohio, Kentucky, and Tennessee have accepted. At an organizational meeting, Eric V. Weber, of the Eureka Oil Company, was elected chairman; J. T. Rhodes, Standard Oil Company (N. J.), was named vice chairman for Tennessee, and J. B. Hutchinson, Aetna Oil Company, vice chairman for Kentucky. This committee is proceeding with plans for expansion and organization down to the county level.

W. J. Arnold, The Pure Oil Company, was selected as chairman of the Great Lakes States district, along with the following vice chairmen: James E. Truesdell, Austin Oil Company (Michigan); James G. Sinclair, Shell Oil Company (Indiana); Stanton Smith, Smith Oil and Refining Company (Illinois); W. R. Pate, Pate Oil Company (Wisconsin). These officers are engaged in committee membership expansion and are scheduling a series of informational meetings.

In the Minnesota-Dakota district, Walter L. Holmgren, of the W. H. Barber Company was chosen chairman along with the following vice chairmen: Thomas B. Murphy, Deep Rock Oil Company (Minnesota); R. J. Coughlin, Westland Oil Company (North Dakota); J. E. Adrian, South Dakota Independent Oil Men's Association (South Dakota). Invitation lists for the district committee are being compiled.

E. Dale Smart, of Skelly Oil Company, is serving as temporary chairman of the Iowa-Missouri-Nebraska district until acceptances can be received and committee officers elected.

In District 3, the Southwest, Fred F. Murray, Oil Well Supply Company, is chairman and John P. Morgan, Sun Oil Company, is vice chairman. The Eastern Gulf district (Mississippi, Alabama, Louisiana, and Arkansas) elected W. M. Vaughney, independent operator, of Jackson, Mississippi, chairman, and the following vice chairmen: N. H. Wheless, Shreveport, Louisiana; T. M. Martin, El Dorado, Arkansas, and James E. Duffy, independent operator, of Grove Hill, Alabama. Members of this portion of the District 3 committee will number more than 100.

In the Texas-New Mexico area of District 3, J. Ed Warren, of the Carl B. King Drilling Company, was elected chairman and Hiram M. Dow, Roswell, New Mexico, attorney, was named a vice chairman, as were Warren L. Baker, of *The Oil Weekly*, Houston, and John P. Morgan, Sun Oil Company, Dallas. This area is organizing by community sections and membership is expected to expand to more than 200.

In the Oklahoma-Kansas area, C. O. Willson, of *The Oil and Gas Journal*, Tulsa, and Lloyd Pickrell, of Wichita, were named vice chairmen. W. G. Skelly, of the Skelly Oil Company, Tulsa, is serving as temporary chairman and invitations to membership are currently being issued to nearly 200 oil men.

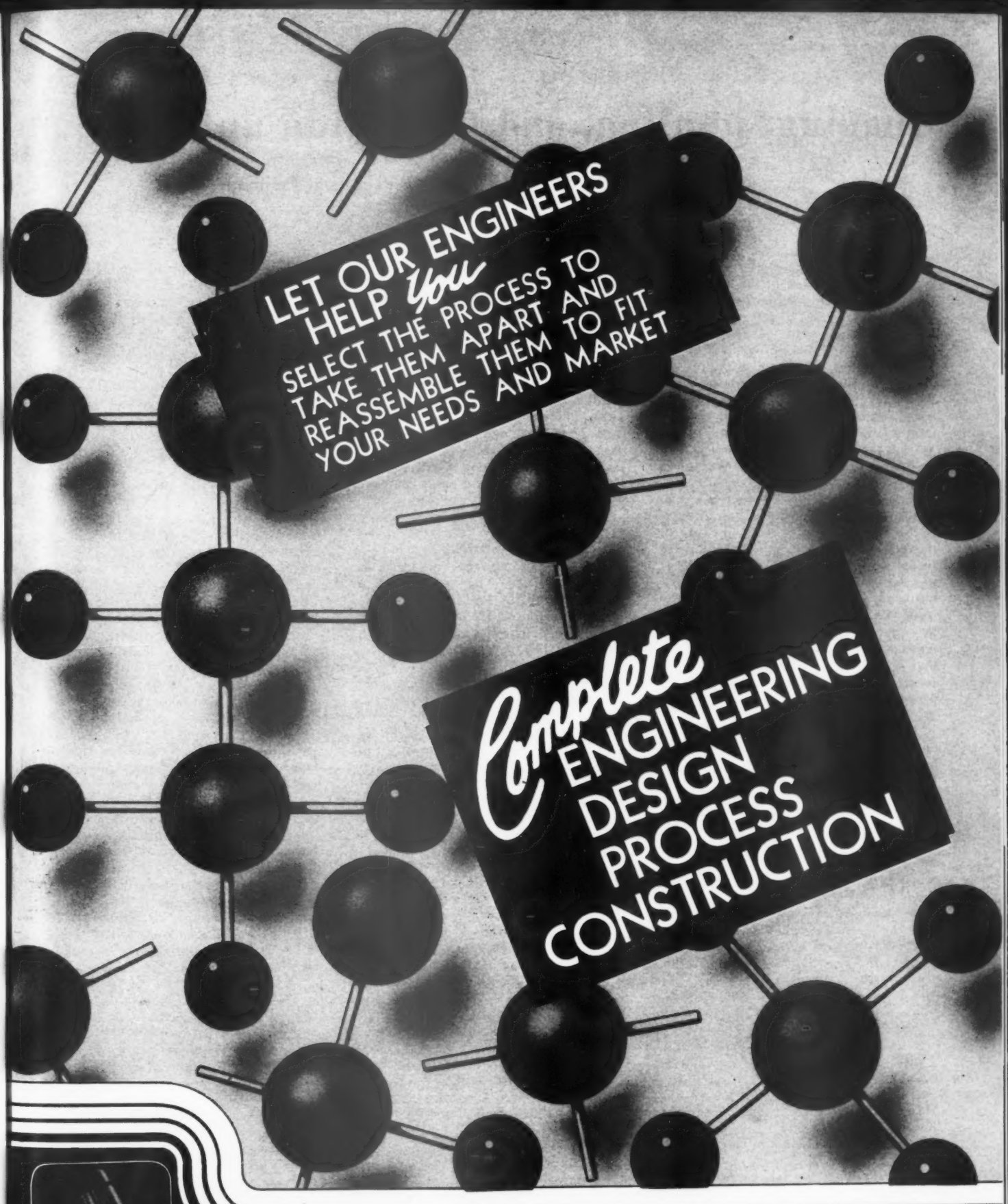
M. H. Robineau, of the Frontier Refining Company, Denver, is serving as acting chairman of District 3. A total of 170 have accepted membership on the district committee.

In District 5, where all 19 men thus far invited have accepted places on the district committee, Don E. Gilman, of the Western Oil and Gas Association, is chairman.

Among editorial material for use in presenting the program and obtaining industry participation is a program display brochure, "Winning More Friends for Your Business," which went to district committees early in May. This brochure, suggesting material for advertising, radio, and promotional use, contains nine proposed advertisements for which mats will be offered, six suggested radio commercials, a poster for plants and retail outlets, two proposed direct mail pieces, and other information presenting the facts about the petroleum industry.

A slide film is being prepared, as well as a study of competition within the industry and booklets explaining the public relations program. The study of competition, by Peter Drucker, will be published as a reference work for educators, editors, writers on business subjects, and economists. In addition, it will be available to the entire oil industry. As part of the public relations program, material in the study will be used in many forms in editorial material emphasizing the industry's highly competitive character.

★ ★ ★



Engineering and Construction Division

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Spacing, pooling, and field-wide unitization*

By **RAYMOND M. MYERS,** Magnolia Petroleum Company

I HAVE been assigned the subject of spacing, pooling, and field-wide unitization—an agreeable subject that has engaged a large part of my attention for the last several years.

To understand this subject, a clear distinction must be drawn between the words "pooling" and "unitization." When leases covering small tracts are consolidated, usually to constitute a drilling unit, it is referred to as "pooling," whereas the consolidation of all leases in a field, or a substantial portion thereof, is referred to as "unitization."

Under the common law, there were no restrictions on the drilling of oil and gas wells. Spurred on by the law of capture[1] the operators endeavored to "git there fustest with the mostest" wells. Whether the desire was to capture a neighbor's oil or only to protect property lines, the result was great waste and the economic loss that always follows the drilling of unnecessary wells. It was seen very early that orderly development and true conservation demanded as a minimum the proper spacing of wells.

● **Texas passed well-spacing rule in 1919.** The first well-spacing rule promulgated in the United States was passed by the Railroad Commission of Texas in 1919, known as Rule 37. It was passed pursuant to a waste statute that placed the enforcement of conservation measures in the hands of that body. This rule prohibited the drilling of wells less than 300 ft apart and less than 150 ft from property lines, and has been upheld as a reasonable exercise of the police power for the prevention of waste and unnecessary fire hazards.[2] This rule has been changed from time to time, the tendency being to increase the distances from the property lines and between wells. This rule is of statewide application. Many fields in the state, however, are covered by special rules that take precedence over the state-wide rule.

The same result is achieved by the establishment of drilling units of specified size. Many of the states, such as Arkansas and Oklahoma, when granting the authority to fix drilling units, place a ceiling on the amount of acreage to be included therein. Drilling units are defined as the maximum area that may be economically and efficiently drained by one well.

These statutes and the rules pursuant thereto usually provide for the granting of exceptions after notice and hearing, and it is the abuse of this right and the fixing of drilling units on too small a spacing pattern that has resulted in the drilling of unnecessary wells. In the East Texas field, where the allowable is not reduced because of the smallness of the tract, more than one-half of the wells were drilled as exceptions to Rule 37. The drilling of one well under an exception leads to the granting of others, resulting finally in the virtual abrogation of the rule.

As the number of wells in a field increases, the allowable per well must necessarily decrease. This makes it more and more difficult for the wells to pay out. In many fields the operators unquestionably have invested more money than they have been able to obtain out of production.

I think it may safely be said that any well drilled upon a tract smaller than that established by the spacing rule is an unnecessary well. A. W. Walker, Jr., discussed this whole problem in an address before the Texas Bar Association under the subject of "The Problem of the Small Tract under Spacing Regulations.[3]

● **New Mexico and Arkansas pooling rules.** Several states have attempted a solution of this problem. In New Mexico the statute provides for permissive pooling.[4] where an owner of a tract less than the drilling or proration unit would otherwise be deprived of the opportunity to produce his fair share of the oil or gas. The owner is not denied the right to drill and produce his tract, however, if no waste is involved, but in such case the allowable production from such tract as compared with the allowable production if such tract were a full unit, shall be in the ratio of the area of such tract to the area of a full unit.

In Arkansas[5] the law, after providing for the establishment of drilling units, provides that where two or more tracts are embraced within an established drilling unit, the owners thereof may voluntarily pool their interests and develop the same as a unit, and that if they fail to agree they may be required to do so. The law further provides that if compulsory pooling is found to be beyond the power of the Commission, one who drills on a tract less than the drilling unit shall be penalized by a proportionate reduction in his allowable.

Under the above law, many integration orders have been issued by the State Oil and Gas Commission and its right to do so has not been denied by the courts.[6]

A copy of such an order may be procured from the Commission. This integration order first sets out in detail the rights of the parties. After reciting that the various interests are integrated for the purpose of preventing waste and to avoid the drilling of unnecessary wells, it sets out how the proceeds of the oil and gas are to be divided, designates an operator, provides for the drilling of a well or wells, provides that the operator shall receive all the proceeds of the sale of the oil and gas, and deduct the operating expenses attributable to the other interests. Attached to the order is a detailed "Accounting Procedure." The operator can obtain the non-operator's share of the expense of development and operation only out of the proceeds of production. Thus, the entire risk of obtaining a dry hole is on the shoulders of the operator who is normally the proponent of the order.

● **Louisiana and Oklahoma pooling rules.** The Louisiana law[7] provides for voluntary pooling but further provides for enforced pooling where the owners of two or more separately-owned tracts that are embraced within a single drilling unit fail or refuse to develop their tracts as a unit. This right of the commissioner has been directly upheld by the courts in the case of Hunter Company vs. McHugh, 11 So. (2d) 495 (1942), appeal dismissed 320 U. S. 222.

The enforced pooling provision of the Oklahoma statute is the most detailed of any.[8] Under this law the Commission is given the power to establish "well-spacing and drilling units of specified and approximately uniform size and shape for any common source of supply or prospective source of supply in this State." There is, however, a very definite limitation on the jurisdiction of the Commission to establish well-spacing units of more than 10 acres in size in oil pools, as in these cases the owners of at least 66-2/3 per cent of the acreage covered by leases of record must consent to the size of such spacing units. There is also a ceiling on gas wells of 640 acres and on oil wells of 40 acres above 8000 ft and 160 acres below 8000 ft. Pooling of two or more separately-owned tracts within the spacing unit is permitted. Where the owners have not agreed to pool their in-

*Part of a paper presented at the recent Mississippi Bar Association meeting at Jackson, Mississippi.

Note: Since this talk was made, the Secretary of the Interior has issued regulations and a suggested unit agreement, which is found on page 528 of the Federal Register of date January 25, 1947. These regulations have also been mimeographed and distributed by the Mid-Continent Oil and Gas Association, MCM 12274, February 11, 1947.

[1]See R. E. Hardwicke's article in 13 Tex. Law Rev. 391.

[2]Brown vs. Humble Oil & Refining Company, 83 S. W. (2d) 935 and cases therein cited.

[3]*Texas Law Review*, vol. 17, p. 157 (Proceedings Texas Bar Association).

[4]New Mexico Laws of 1935, Chapter 72, Section 12. Section 69-213 New Mexico Statutes 1941 Annotated.

[5]Laws of Arkansas (1939), p. 219, Act 105, Sections 11 (par. j), 14 and 15, as amended.

[6]See dicta in Yelvington vs. Alston, 180 S. W. (2d) 120.

[7]Louisiana Act 157 of 1940, Sections 8 and 9.

[8]Title 52, Section 87, Oklahoma Statutes Annotated.

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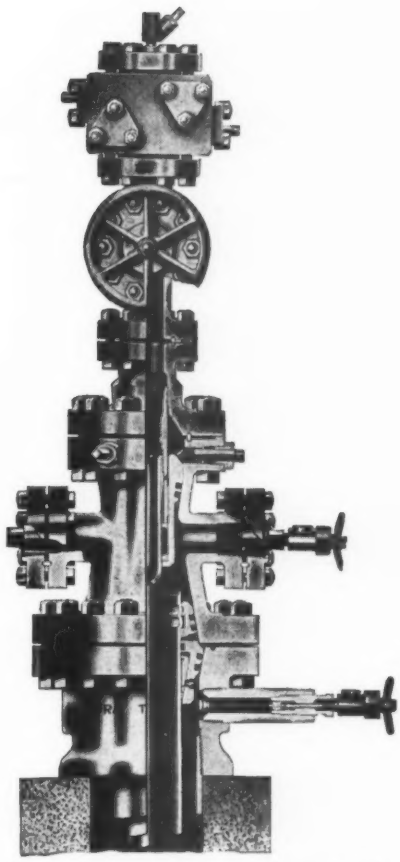

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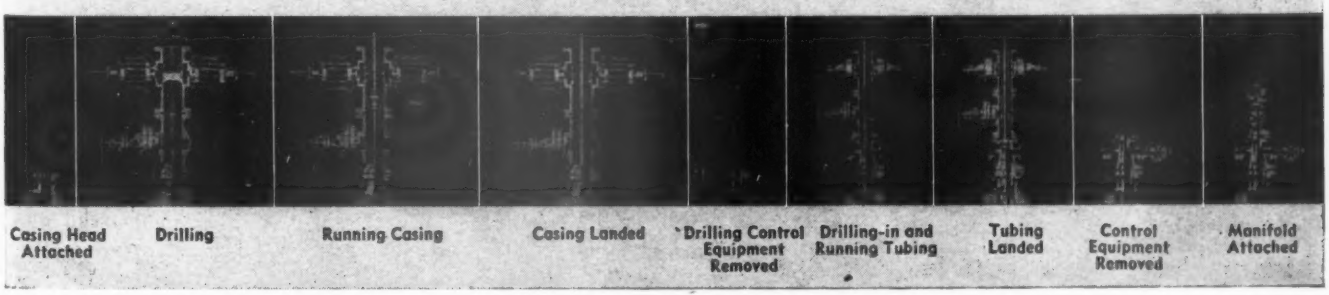

terests, they may be required to do so. The law provides in detail for notice and hearing, and details what the order shall contain.

Enforced pooling in Oklahoma was upheld in the case of Patterson vs. Stanolind Oil and Gas Company.[9]

Table 1 presents a list of the conservation laws of the various states containing spacing and pooling provisions. This list indicates where such provisions may be found in the statutes and also gives the names of the conservation authorities in whose hands jurisdiction is placed.

Further authorities upholding the power of regulatory bodies to require pooling of small tracts in order to conform to prescribed spacing patterns for the purpose of preventing waste, protecting correlative rights, removing fire hazards and other dangers are:

Marrs vs. City of Oxford, 32 Fed. (2d) 134; (8th Circuit Court, 1929), cert. denied 280 U. S. 573;

Tysco vs. Railroad Commission, 12 Fed. Supp. 195; 12 Fed. Supp. 202;

Marblehead Land Company vs. City of Los Angeles, 47 Fed. (2d) 528 (9th Circuit Court, 1931) cert. denied 284 U. S. 634.

If a spacing rule is a good conservation measure, if it is an economic boon in preventing the drilling of unnecessary wells, then it follows, it seems to me, that enforced pooling is necessary. All the laws that require pooling also provide for a fair division of the oil and gas beneath the drilling unit. Many, I know, have reason to fear the encroachment of regulatory authorities, but here is one area where these authorities may, I believe, function under law to the best interest of the industry.

● **Voluntary methods of pooling.** Leases may be pooled by the joinder of the land owners in the execution of a community lease that, by its terms, constitutes a form of pooling. It has been held, however, that leases may just as effectively be communitized where all the land owners sign together an ordinary lease and it does not appear that the lessors did not intend to pool the leases.[10] There are many unanswered problems relating to community leases, at least in Texas, and it seems to me that it is preferable to approach the problem frankly with a pooling agreement.

Voluntary pooling takes another form in cases where a pooling provision is included in an oil and gas lease. A typical provision reads as follows:

"Lessee is hereby granted the right to pool or unitize this lease, the land covered by it or any part thereof with any other land, lease, leases, mineral estates or parts thereof for the production of oil, gas or any other minerals. No unit for the production of oil shall embrace more than forty (40) acres; provided, however, that if any Federal or State

[9]77 Pac. (2d) 83 (1938), appeal dismissed 305 U. S. 376; see also Croxton vs. State (1940), 97 Pac. (2d) 11.

[10]French vs. George 159 S. W. (2d) 566 (Tex. Civ. App.) 1942, error ref'd.

TABLE 1. Provisions in some state laws providing for spacing and pooling.

ALABAMA—Code 1940—Supp., Title 26, Sec. 179(6), Acts of 1945, Act. No. 1, Secs. 12, 13; State Oil & Gas Board, University, Alabama.

ARKANSAS—Acts of 1939, Act 105, p. 219, Sec. 11-L, 14, 15; Arkansas Oil & Gas Commission, El Dorado.

CALIFORNIA—Deering's Codes Pub. Resources, Div. III, C-3 Secs. 3600-3605, as amended, Stats. of 1945, Ch. 139 and 141; Department of Natural Resources, Division of Oil and Gas, state oil and gas supervisor, Sacramento 14; Warren T. Hannum, director of natural resources, State Office Building, Sacramento 14; Reed D. Bush, state oil and gas supervisor, Ferry Building, San Francisco 11.

COLORADO—1935 Stats, Ann. Ch. 118, Sec. 38-52 and Sec. 64-67; Rules & Reg. Rule 2-C; Gas Conservation Commission, Denver, Colorado; Warwick M. Downing, 824 Equitable Building, Denver 2; H. C. Bretschneider, First National Bldg., Denver 2; Lafayette Hughes, 616 Majestic Bldg., Denver 2; W. Roy MacGinnis, 300 Logan Street, Denver 9.

FLORIDA—Fla. Stats. Ann., Vol. 14, Supp. Secs. 377.01-377.40, Secs. 21, 22, N. B. 284, Laws of 1945; State Board of Conservation, Tallahassee; governor is chairman.

GEORGIA—Ga. Laws 1945, p. 366, Sec. 14; Oil and Gas Commission, Waycross; Geo. M. Bazemore, chairman, Waycross; J. A. Pope, Alamo; Paul H. Ploeger, Darien; C. W. Deming, director, Waycross; (Pooling like Arkansas and Louisiana).

ILLINOIS—Jones' Ill. Stats. Ann. Vol 16, C. 104, Secs. 82-84, Laws 1941, Vol. 1, p. 934; Department of Mines and Minerals, State Capitol, Springfield; Robert M. Medill, director, 401 United Mine Workers Bldg., Springfield; C. C. Curtis, oil conservation supervisor, Oblong; J. W. Spence, administrative assistant, Geff; H. Bruce Thompson, West Salem; Charles E. Jones, technical advisor, Robinson; Samuel F. Patterson, petroleum engineer, Springfield.

KANSAS—Gen. Stats. of Kansas, 1941 Supp., Sec. 55.602; State Corporation Commission, New England Bldg., Topeka; Richard B. McEntire, chairman, Albert L. Orr, commissioner, DeWitt M. Stiles, commisioner, Victor L. Kirk, secretary, all at New England Bldg., Topeka; T. A. Morgan, director of conservation division. 800 Bitting Bldg., Wichita 2.

LOUISIANA—La. Gen. Stats. Dart, Vol. 3, Secs. 4741-11-4741.31; Act 157 of 1940, Sec. 3(m), 8, 9 (pooling); Commissioner of Conservation, Capitol Bldg., Baton Rouge; Jos. L. McHugh, commissioner, 900 Capitol Bldg., Baton Rouge; Dr. J. Huner, state geologist, Baton Rouge; F. V. Carter, chief engineer, Baton Rouge.

MICHIGAN—Mich. Pub. Acts 1939, No. 61, Sec 6(j), Sec 13 (pooling); Commission of Conservation, Supervisor of Wells, Lansing; P. J. Hofmaster, director, Department of Conservation, State Office Bldg., Lansing 13.

MISSISSIPPI—1942 Code Ann. Secs. 6132-6179; State Oil and Gas Board, Jackson; Gov. Thomas L. Bailey, Jackson; Greek L. Rice, attorney general, Jackson; Guy McCullen, land commissioner, Jackson; H. M. Morse, supervisor, Jackson.

MONTANA—Rev. Codes of Montana, 1935, Ann. Secs. 3554.1—3554.19; Oil Conservation Board, Helena; A. B. Cobb, chairman, Box 1122, Great Falls; M. R. Wagner, Cut Bank; C. A. Heackel, Box 147, Bozeman; L. J. Yealy, vice-chairman, Shelby; Casper T. Oien, Drawer "B," Oilmont; R. P. Jackson, secretary, Box 1122, Great Falls.

NEW MEXICO—N. Mex. Stats, Ann. 1941, Title 69, Sec. 213; Oil Conservation Commission, Box 871, Santa Fe; Governor John J. Dempsey, chairman, Box 871, Santa Fe; R. R. Spurrier, secretary, Box 871, Santa Fe; John E. Miles, Box 871, Santa Fe.

NORTH CAROLINA—S. L. 1945, Ch. 702, p. 951; Ch. 765, p. 1073; Department of Conservation and Development, Petroleum Division, Raleigh.

NORTH DAKOTA—Rev. Code of 1943, Secs. 38-0801 to 38-0823; Industrial Commission, Bismarck; governor is chairman.

OHIO—Page's Ohio Gen. Code, Ann. 1946 Replacement, Secs. 898-181 to 898-200; Department of Industrial Relations, Division of Mines, Columbus.

OKLAHOMA—O. S. A. Title 52, Sec. 87, Corporation Commission, Capitol Office Bldg., Oklahoma City 5; Reford Bond, chairman, Ray O. Weems, vice-chairman, W. J. Armstrong, Walker T. Pound, all at Capitol Office Bldg., Oklahoma City 5.

SOUTH DAKOTA—1943 S. L., Ch. 153, p. 169, Sec. 4 (g) (4), Sec. 6(c) (12); State Oil and Gas Board, State Capitol, Pierre; governor is ex-officio chairman.

TENNESSEE—Williams' Tenn. Code Supp. Secs. 5240.1-5240.5, Acts of 1943, Ch. 64; State Oil and Gas Board, Nashville, Paul Mathes, commissioner of conservation, is chairman, Nashville.

TEXAS—Vernon's Civ. Stats. Vol. 17, Title 102, Art. 6029, Rule 37; Texas Railroad Commission, Austin; Olin Culberson, Austin; Ernest O. Thompson, chairman, Austin; Wm. J. Murray, Jr., Austin; L. D. Ransom, secretary, Austin; Jack L. Baumel, director of production, Austin.

Arizona, Colorado, Idaho, Indiana, Iowa, Kentucky, New York, Ohio, Oregon, Pennsylvania, Utah, Washington, West Virginia, and Wyoming do not have the more comprehensive type of conservation statutes. The laws of these states are limited to prohibiting waste of natural gas, prescribing methods of plugging wells, etc.

law, Executive order, rule or regulation shall allocate a producing allowable on acreage per well, then such units may embrace such acreage as may be so prescribed. Lessee shall file written unit designations in the county in which the premises are located. Drilling operations and production on any part of the pooled acreage shall be treated as if such drilling operations were upon or such production was from the land described in this lease, whether the well or wells be located on the land covered by this lease or not. The entire acreage pooled into a unit shall be treated for all purposes, except the payment of royalties on production from the pooled unit, as if it were included in this lease. In lieu of the royalties herein provided, lessor shall receive on production from a unit so pooled only such portion of the royalty stipulated herein as the amount of his acreage placed in the unit or his royalty interest therein on an acreage basis bears to the total acreage so pooled in the particular unit involved."

In the exercise of the powers here given, the lessee must exercise good faith. This means, among other things, that lessor's productive land cannot be pooled with unproductive land to the disadvantage of lessor.[11] The power to pool must be exercised within the terms of the authorization.[12] I believe that the inclusion of the above wording in an oil and gas lease will be found ample for the purpose. Where it is desired to limit the size of gas units, such a provision may also be included.

● **Advantages of field-wide unitization.** It is difficult to overestimate the advantages accruing from unitization in the field of conservation and efficient operation. Without it, cycling operations, repressuring, pressure maintenance, and the efficient development and production of a field as a whole are practically impossible. A common pool or field is a unit by nature and the pressures therein, whether hydrostatic or gas, are common to the whole reservoir. The position of the oil and gas in the pool does not, of course, follow property lines, and therefore to adhere to property lines in their development is to drill unnecessary wells, and to produce oil and gas with the least efficiency. Large economies result through avoiding duplication of equipment, through centralized management, and in other ways. Through this decreased cost of operation, the abandonment of wells is delayed.

The purposes for which unitization may be used or combinations of such purposes, are as follows:

1. Salt water disposal.
2. Oil production in an oil field.
3. Water flooding.
4. Gas production.
5. Cycling operations.
6. Pressure maintenance and storage.
7. Repressuring.

One of the methods of disposing of salt water is to place it in sands or reservoirs beneath the surface by means of injection wells. Where this operation is apt to encroach on the neighbor's land, the need for unitization arises.

Radar will be installed on all 14 seagoing vessels of Standard Oil Company of California. Radar was built into one vessel last fall.

☆ ☆ ☆

● **Unitization fosters pressure maintenance and increases in recovery.** The increase in the amount of oil that may be produced from an oil field by pressure maintenance following unitization is astonishing. The experts say that under ordinary primary production methods only about 25 per cent of the oil originally in place can be recovered. By unitizing the field and returning the gas to the oil formations, the amount of oil ultimately recovered can be doubled. If gas from the gas cap is produced but not reinjected, the pressure in the gas area decreases, with two results. First, the oil migrates to the gas sand where through wetting of the sand it becomes irretrievably lost, and second, oil production from oil wells decreases because of lack of pressure.

Casinghead gas and gas cap gas that often are wasted are saved for future use, and the economies that I have mentioned also benefit the industry.

Water flooding consists of the injection of water through properly spaced input wells into an oil-producing stratum for the purpose of washing the sands and carrying the oil before it into the bore of the producing wells, thus increasing the percentage and rate of recovery of oil from the stratum. As a secondary recovery method, it seeks to recover oil that would not be otherwise recoverable. Cases are known where ultimate production has been doubled by this method. For the most effective and safest use of this operation, unitization is needed so that property lines can be disregarded.

For a discussion of some legal aspects of water flooding, see the article by Earl A. Brown and myself in the June, 1946, issue of the Texas Law Review.

Cycling (or "recycling") in an operation used in gas-condensate fields involving the production of gas containing liquid hydrocarbons from properly spaced wells, the processing of the gas in a plant, and the return of the residue gas into the formations from whence it came. It permits the sale of its liquid content in the form of propanes, butanes, gasoline, and heavier products, avoids waste of gas, maintains the pressure in the pool until all wet gas is exhausted, thereby preventing retrograde condensation, and then constitutes a supply of dry gas for sale, held in the best storage known to man. This operation is the last word in conservation and efficient production.

D. R. Knowlton, who became well known for his fine services during the war in the Office of the Petroleum Administration for War, lists the advantages that accrue to the producer from unitization as follows:

1. Less capital investment required
2. Lower development cost
3. Lower operating cost
4. Products would be made more responsive to the producer's needs
5. Increased acre oil yield
6. Increased gas value
7. Stabilized business
8. An investment more readily salable
9. More actual control over business
10. More dependable crude supply for the other branches of the business
11. Saving on plant capacity
12. Saving on pipe line and storage tanks.

In many states unitization has been accomplished by voluntary action under permissive statutes[13] but Alabama, Florida, Georgia, Louisiana, and Oklahoma approach compulsion, especially with reference to cycling.

The best law covering field-wide unitization is found in Title 52, beginning at Section 286 of the Oklahoma Statutes Annotated. This statute, covering the unitized management of common sources of supply is, in fact, not entirely compulsory, as the Commission does not take jurisdiction except upon the petition of lessees of record of 50 per cent or more of the area of the common source of supply. Lessees of record of 15 per cent or more of the unit area or proposed unit area may veto the plan. This will not constitute too great an obstacle to the unitization of fields, however, as it is compulsory as to royalty, and it is in this field that operators have found their chief difficulty. This law should be studied in detail but, briefly, it provides for a finding on the part of the Commission of the feasibility of the project and sets out what the order must contain. The provisions of the unit agreement are, in general, similar to the plan of unitization that I have given you. The nature, purposes, and functions of the unit, and the liability of the owners of oil and gas rights therein, are provided for in the order. Provisions for amendments and enlargement of the unit are also included. Such agreements are not violative of the anti-trust laws of the State of Oklahoma.

This statute has not as yet been tested in the courts, but an application has been filed with the Corporation Commission covering the West Cement Medrano Sand Pool in Caddo County, Oklahoma. Hearing on this application began on December 9, but has not yet been concluded. This matter will certainly be carried through the courts. The sanction by the courts of this statute will be a great boon to the industry and to conservation authorities alike.[14]

Voluntary agreements of one kind or another have been used extensively and for many years in consolidating leases into units, field-wide in their scope, and these agreements have been particularly useful in later years with the advent of gas-condensate fields. ★ ★ ★

[11]Imes vs. Globe Oil and Refining Co. 84 Pac. (2d) 1106; Oklahoma Supreme Court.

[12]Schlittler vs. Smith, 101 S. W. (2d) 543, Texas Supreme Court.

[13]In Texas article 6008, section 21, is limited to gas.

[14]See *Oil and Gas Journal*, December 7, 1946, p. 80.

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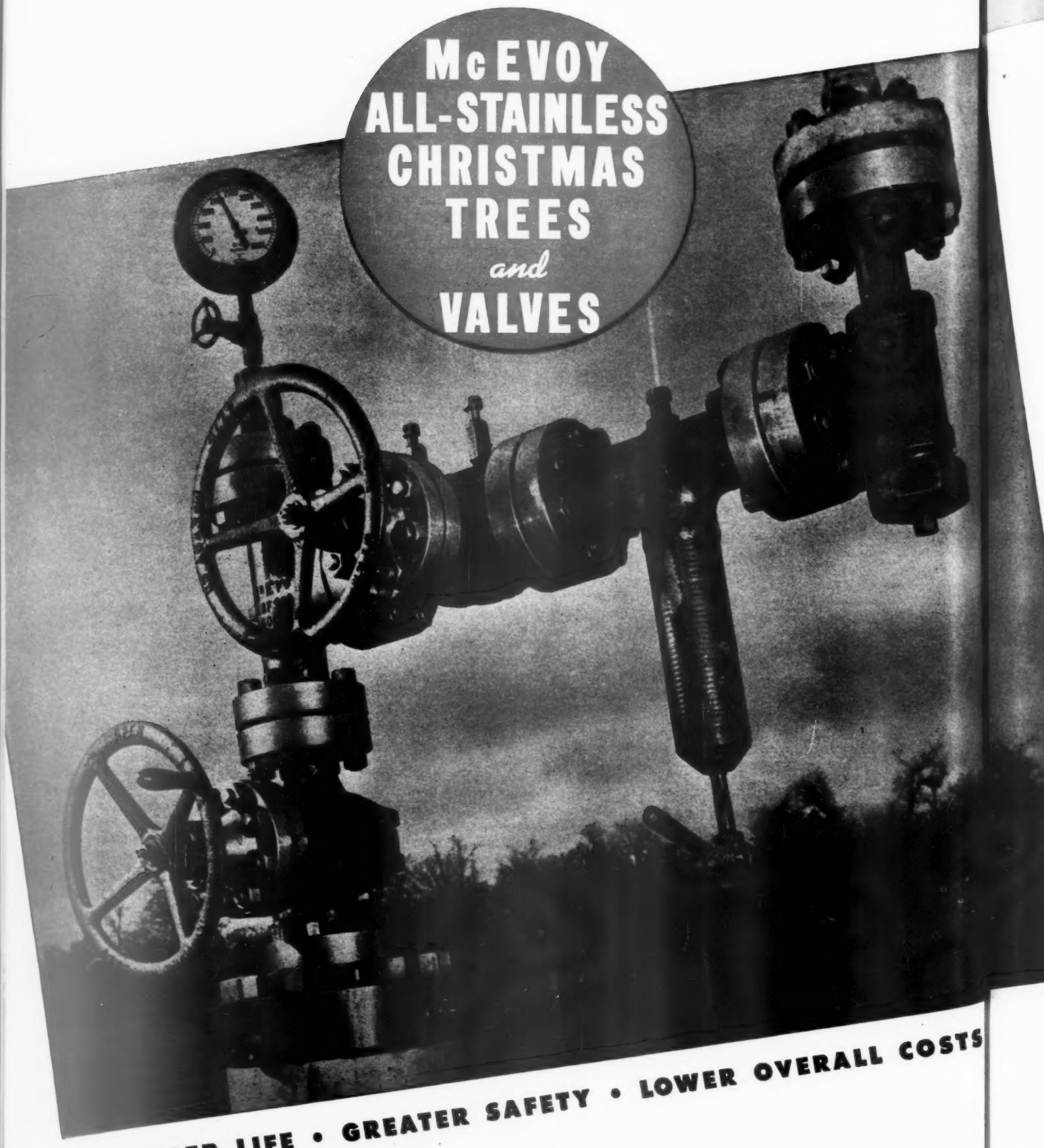

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ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

Design and operation of swabs for oil wells

By **JIM A. WILSON,** Equipment Engineers, Inc.

Three-cup tubing swab assembly that has completed its job of bringing in a well. It is run into the well on a wire line.

ALL swabs have two main principles of operation that control their design. First, it is essential that a swab be so designed as to drop easily through a pipe containing fluid, and, second, it is necessary that when a swab is pulled upward, it bring with it that fluid through which it dropped.

EXCLUSIVE

The reasons for these fundamental principles are realized when the purpose of a swab is known. The first use of a swab is to "bring in" a newly drilled well after the drill pipe is removed and the tubing is run. A considerable amount of drilling mud, cement, and water is usually still in the well as a result of the completion of the drilling plan. This fluid column can prevent the well from flowing. The simplest way to remove the column is by lowering a swab on a wire line (cable) to a depth selected by the swabber, then pulling the swab out. Other swab uses are cleaning out old wells and "kicking-off" wells that threaten to stop continuous flow. In the kick-off of a well by swabbing, it may be necessary to make only one round trip; when bringing in a well, it may be necessary to swab intermittently for weeks.

Swabbing is not a particularly hazardous phase if oil-field work, but then no activity with the inside of a well is entirely without dangers. Consider the swabbing of deep wells that have considerable semi-dormant gas. When the swab starts out of a 10,000 ft well with a large load of fluid and 8000 ft of wire line above it and a large volume of gas below it, it is a good idea to locate a clear path away from the well in case of need. From a safe distance, it no doubt would be entertaining to watch that 8000 ft of cable come out over the top of a derrick. This has happened when the gas wouldn't wait for the swabber to pull out his swab.

● **Four types of swabs:** A swab is one of the oldest and most universally used of all oil-field specialty items. There are four main classifications of swab designs just as there are two main principles of operation.

The first design in use consisted of leather placed about a piece of pipe having a check valve through which the fluid could flow only in one direction. A refinement of this idea is shown in Fig. 1. This early design meets both conditions for swab operation, for obviously it should be inefficient due to the poor sealing qualities of the ball shape against the inside diameter of the tubing or casing wall. Even with rubber as a substitute for leather, the loss of fluid might be great, and there is no adequate means of compensating for wear on the rubber while it is being pulled out of the well. An improved version of the ball design is the split ball (see Fig. 2). This design eliminates the need of a check valve in a pipe, because the two halves of rubber separate on the downward travel and bypass the fluid, and they close on the upward pull. The separation provides an enormous bypass area permitting rapid descent, but the loss of fluid on the upward pull is not lessened, because it has the same ball principle as that shown in Fig. 1.

A big improvement in swab design occurred when a cup-shaped rubber element was installed in a pipe having a

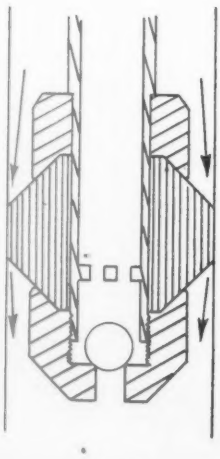


FIG. 1

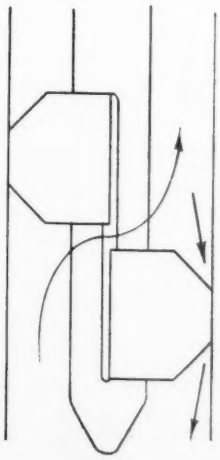


FIG. 2

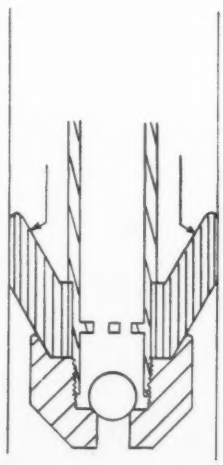


FIG. 3

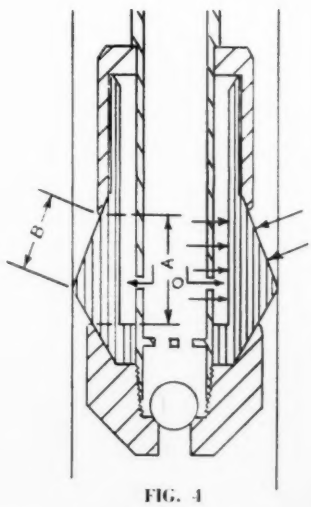
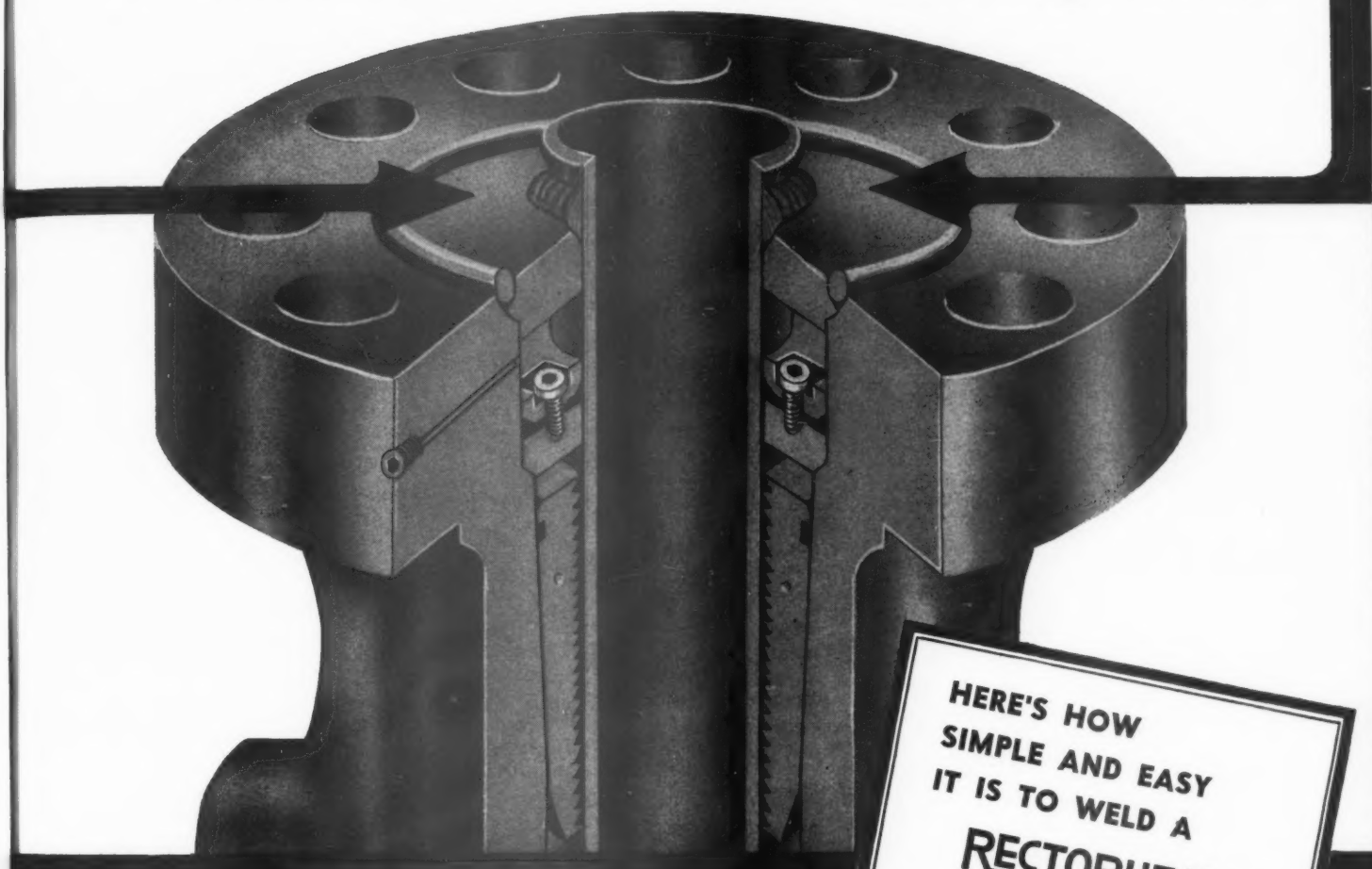


FIG. 4

It takes less than an hour to weld this RECTORHEAD Casing Head



No Distortion...No Strain... No Stress Relieving Required

RECTORHEADS have none of the objectionable features to welded casing head seals. Designed for welding speed, simplicity and security, they are entirely free of resilient packing, thus eliminating seal failures due to deterioration and the costly risk of packing replacement.

The recessed floating ring eliminates distortion set up by flange bolt pressure... preheats and cools uniformly with pipe so that no strain develops during or after welding, and no stress relieving is required.

Thousands of RECTORHEAD installations have proved the correctness and value of their design from every standpoint. Use Rectorheads on your well for dependable, permanent, trouble-free protection for the life of the well.

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REPRESENTATIVES IN ALL ACTIVE FIELDS

HERE'S HOW SIMPLE AND EASY IT IS TO WELD A RECTORHEAD

Following these instructions, your regular welder can make the weld on any grade of pipe without special equipment.

Clean all parts with wire brush.

Heat elements to 500 deg. F.

Level and tackweldingto casing—4 places.

Use tempilstik or its equivalent and maintain heat throughout welding operation.

First bead: Drag 1/8" Fleetweld No. 5 rod or equal in bottom of groove.

Peen each bead carefully.

After first weld: Use 5/32" Fleetweld No. 5 rod or equal.

Use enough beads, not less than three, to fill groove.

RECTOR

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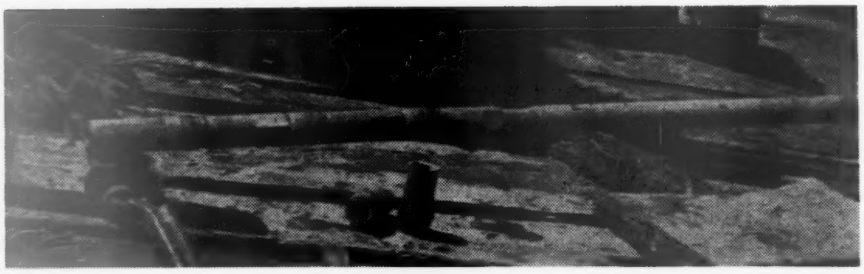


Three-cup tubing swab assembly as it is laid on the derrick floor for changing cups. The spacers have to be unscrewed separately to replace the cups.

check valve (see Fig. 3). In this design automatic compensation for wear of the rubber occurs and there is very little loss of fluid. In fact, the total fluid load is exerted in forcing the cup against the wall. This design, however, may cause considerable and unavoidable wear of the cup as the swab is pulled out. The speed of descent through the fluid in the well is controlled by the size of the area through the pipe.

The latest improvement in swab design occurred when the balloon type of Fig. 4 was created. In this design the fluid load is used to expand the cup from the inside through holes in the swab pipe, thus creating and maintaining a seal against the inner wall of the pipe being swabbed. This is considered a major improvement because the expansion is controlled. The same fluid load that expands the cup also acts to contract the cup, because its force is exerted both internally and externally. As the unit pressures are equal, it is only necessary that the inner area "A," which is subject to expansion pressure, be greater than the outer area "B," which is subject to contraction pressure. Because of this ratio of pressures, the cup will maintain a sufficient seal to pull a full load—heavy or light—and yet be controlled so that there will be a minimum of expansion pressure regardless of load, thus preventing excessive wear of the cup. The rate of descent of the swab is controlled by the area through the swab pipe-mandrel.

● **Desirable characteristics of swabs:** A user of swabs wants the following features in the swabbing tool he uses:

(1). A swab that will fall as fast as he is willing to let his line unreel.

(2). A swab whose cups will pull a full load and give the maximum number of trips before requiring him to stop swabbing in order to change cups.

(3). A swab designed for quick and troublefree cup changing.

(4). A swab that will pull both light and heavy loads without fluid loss or disintegration of cups.

(5). A swab that will not lose any of its parts in the well.

Taking all four swab designs into consideration, many users conclude that the controlled expansion type of Fig. 4 is the most efficient and desirable design. Improvements in all types have placed them on a par with regard to satisfying the condition of rate of fall, the possible exception being the split-ball type. Many users believe that the design of Fig. 4 best meets the condition of cup life and amount of load pulled. Most swabbers differ in their opinion regarding which type is the easiest for changing cups.

The controlled expansion swab meets the condition of pulling light as well as heavy loads, but all swabs have been known to leave some of their parts in the well under severe conditions. This fact can be caused by inferior workmanship or materials, or by using a worn out swab. These statements are not made from the consideration of theory alone, but are based on actual field tests and normal swabbing operations.

● **Swabbing operations are usually contracted:** A large part of all swabbing is now done by swabbing contractors. The principal reason for this is because the oil companies have found that it is more economical to contract this phase of well servicing than to keep expensive swabbing units idle for long periods of time.

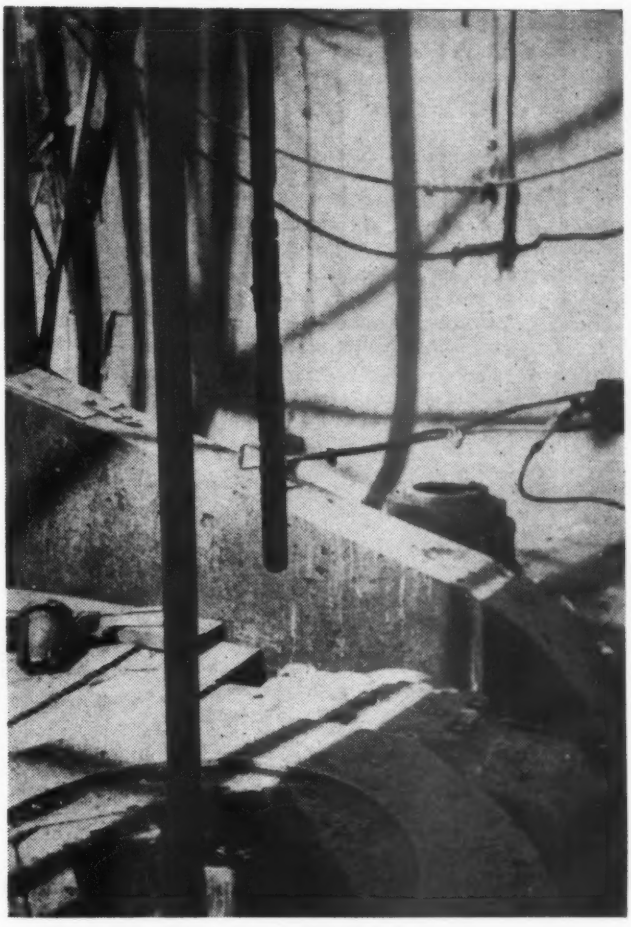
The usual procedure is for the swabbing contractor to supply all necessary equipment for swabbing. The well owner pays by the hour for the service plus the cost of the swab cups used. The contractor supplies a swabber and his assistant, a swabbing truck that consists of a power-operated drum and swab line, a swab and extra cups, sinker bars and rope socket, one or two blocks depending upon how the line is pulled through the derrick, and a wire-line wiper. The contractor will also supply the lubricator unless he knows that a suitable piece of pipe will be available at the well.

The sinker bar adds weight to the swab to enable it to start its fall from the surface. The rope socket connects the sinker bar to the wire line at the top and the swab is screwed to the bar at the bottom. The lubricator consists of a piece of tubing long enough to enclose the rope socket, sinker bar, and swab. The lubricator is screwed into the top of the christmas tree and the wire-line wiper is screwed on at the top.

● **Swabbing through casing:** Most of the article has applied to the procedures for swabbing tubing. The principles of swab design and operation in the casing sizes is the same as that for tubing with the main exception being the care that must be taken to avoid overloading the casing swab. For this reason, most swabbers prefer to run a casing swab that has a relief valve to unload automatically the excess amount of fluid being pulled. In the tubing sizes the rubber cups can be burst intentionally by the swabber if he picks up too large a load, but this is almost impossible to do with a casing size cup. In all cases, however,

Swabbing truck as the hoist is engaged in the swabbing process of pulling and lowering the swab in the well. The upward trips usually bring a load of fluid ahead of the swab.

Two-cup casing swab assembly as it hangs in the derrick before being run into the open casing of a well.



Three-cup tubing swab assembly as it hangs in the derrick next to the joint of 2-in. tubing that serves as lubricator.

the swabber will take care not to overload, mainly because of the excess wear on his equipment and the danger of breaking his line.

Approved methods of swabbing vary as much with operators as do the well conditions. As an example, one operator would never use a line larger than $\frac{5}{8}$ in. in $2\frac{1}{2}$-in. tubing, whereas another operator may prefer a $\frac{3}{4}$ in. line. Another example of difference of opinion is the tandeming of two different makes of swabs by one operator, whereas another will add a third cup to the one type of swab and prove to his satisfaction that the efficiency of operation is better with the 3-cup swab alone.

Then there is always the question in the operator's mind: How big a load should I try to pull on the first run? Nearly all operators will play safe by getting under what they know is less than the maximum they can pull easily. There is the known case where the operator went entirely to the bottom of a 4100-ft well on the first run and came out without any particular effort. The load was mud and water left from drilling. He was not at all concerned and considered this to be the normal procedure, because he had swabbed similar wells in that area and knew the high pressure would assist him in pulling the swab.

In a different area on a wildcat well, another operator went down only 500 ft on the first run. His load was $11\frac{1}{2}$-lb mud and he didn't want to take any chances of overloading. This particular well was 8800 ft deep and came in when the swabber had made the last pull from 4600 ft. Five packers were used before one was found to be satisfactory in holding the pressure of the mud left in the casing annulus.

● **Bringing in the well:** The swabber will frequently bring in a well by agitation of the fluid. In this method, when and if the swabber feels that the well is about to begin flowing, he will drop to a depth to obtain the normal load, raise the column about 1000 ft, then relower about 500 ft. Raising and lowering the swab in the fluid without coming out of the hole agitates the fluid to the extent that sufficient gas is released from solution to cause flow. This method induces flow, but will not always bring the well in.

The following is an actual case history of a swabbing operation and it is given to illustrate the effect that swab design can have on the efficiency of a swabbing job.

Well location: Cherokee County, Texas.

Well condition: 5100 ft deep; 7-in. casing; $2\frac{1}{2}$-in. tubing; no packer; casing annulus and tubing were full of water and mud; very little gas in the fluid column.

Procedure: Swabbing was begun Sunday night, March 23, 1947, at 7:00 p.m. Six trips were made in 2 hr and six cups were used. At 9:00 p.m. the swab design of Fig. 4 was installed and it was used until midnight, and made 13 continuous trips without changing cups. The swab was then pulled into the lubricator, and the well was shut in for the night. Swabbing was resumed the next morning at 7:00 a.m. with the same swab, and it was run continuously until the well came in at 2:25 that afternoon. Twenty-five trips were made during this second period without a change of cups, giving a total of 38 runs for the cups. As there was little help from the reservoir pressure or the gas in the formation, it was necessary to remove the water in stages by getting under as much load as the swabber felt he had power to pull. On the last pull, the swabber went to the bottom for the first time.

☆ ☆ ☆

The Independent Petroleum Association of America will hold its annual meeting in Oklahoma City, September 29 and 30. All activities of domestic oil and gas industries will be covered.

● **The cost of swabbing wells:** It is not uncommon for swabbing charges to exceed $1000 a well. On such jobs the cost of the cups used can be a considerable part of the charge. This factor demands careful consideration when deciding which type of swab to use. A breakdown of swabbing charges can be covered by two classes: (1) charge for the number of hours on the job, and (2) the charge for the cups used. A breakdown of the number of hours on the job can be shown as follows:

a. Time for setting up swabber's equipment.

b. Time for swab to drop (each run). Mostly dependent upon well condition.

c. Time for pulling swab out with load (each run). Mostly dependent upon well condition.

d. Total number of runs. Dependent upon well condition and loss of fluid past swab.

e. Time used in changing cups (20-30 min each time).

f. Standby time (1 hr and up depending upon when customer releases swabbing unit).

Using the above case history to figure possible costs due to the number of cups used, an estimate would be as follows: The well was swabbed in after a total of 44 trips. The 2-cup swab used at first made six trips and required six cups. This is an average of two trips per cup change. For all 44 trips this would have meant stopping to change cups 22 times. At 20 min for each change, the time lost would have been 440 min or 7⅓ hr plus the cost of 44 cups. By using the cup design for Fig. 4, no time was lost in changing cups, and the only charge for cups was the charge for the three cups originally on the swab.

The correct selection of the swab for the job to be done pays off. The well owner saves money, and the swabbing contractor has the satisfaction of turning in a charge sheet and a report for the most efficient work possible. This is an excellent means of influencing the well owner to hire that same swabber for future work.

● **Swabbing practices to be avoided:** Swabs can be badly mistreated even though they are of simple and sturdy construction. This mistreatment is unintentional and usually can not be helped. An example of this would be accidental overloading. This may result in parting of the swabber's line, bursting of the swab cups, or excessive wear of the cups. Another bad condition is pulling the line at an excessive rate of speed. This creates a condition similar to overloading. In deep wells where there is a heavy column of mud on the formation, it is most important that this load be removed as soon as possible. This means a faster rate of swabbing than would be desirable ordinarily, if maximum cup life were of prime importance.

Today, because of some well hookups, the swab operator must be careful when the fluid load reaches the well head as the use of surface chokes in the line puts an undue back pressure on the swab. The wire line oil saver also is endangered when the speed is not reduced enough to allow the load to go through the choke. In deep wells the tubing weight placed on a packer to insure a seal-off will place the tubing in compression above the packer. It then follows that somewhere just above the packer, the tubing will have a tendency to swing out to the casing wall. The greater the ID of the casing, the more marked will be the curvature of the tubing. This curvature may be so pronounced that the swab and sinker bars will bind and have to be spudded through this portion of the compressed area. This is a dangerous situation, and it will be wise to consider what can happen when the swab is pulled through this section under heavy load. Excessive wear on one side of the cups is a sign of curved tubing or bent sinker bars.

In conclusion, it should be stated that many operators are using more powerful pulling units and larger lines to take care of the tough swabbing jobs resulting from deeper wells. Heavier and heavier loads must be handled by the swabs, and swab manufacturers are developing cup designs that should increase cup life considerably although pulling heavier loads than were ever pulled in the past.

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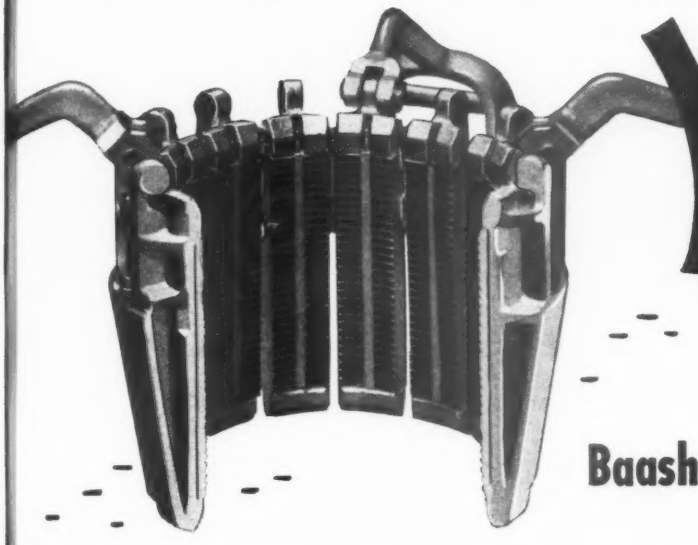

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Baash-Ross Type "UC" Casing Slips

BECAUSE A STRING of casing has a relatively thin wall in relation to its diameter, it is much more easily damaged by unequal slip pressure than are drill pipe or tubing. Yet the weight of a string of casing—particularly under modern deep-hole drilling operations—can be extremely great... *so great, in fact, that even a slight misalignment of the slips or a moderate concentration of slip pressure can cause serious damage to the casing and might even result in losing the casing string down the hole.*

But such risks are now minimized through development by Baash-Ross of a new type of casing slip—the Baash-Ross Type "UC" Casing Slip. The Type "UC" Casing Slip consists of multiple segments, flexibly linked together so that they *w-r-a-p* around the casing like a chain tong to fit the exact curvature of the casing. Each individual slip segment takes the *same* uniform grip on the surface of the casing because *all* of the segments are unitized together—*act* as a unit, *set* as a unit, *grip* as a unit. This assures uniform slip pressure around the full circumference of the casing, eliminating risk of concentrated pressures that crimp the pipe and egg-shape the casing.

THREE BASIC BODY SIZES HANDLE WIDE RANGE OF CASING DIAMETERS

And here's an important point... Only *three* basic body sizes of "UC" Casing Slips are needed to handle *all* popular casing sizes from 7⅝" through 13⅜". As shown in the accompanying table, interchangeable liners are available for each of the three basic body sizes so that each size can be readily adapted to fit different casing sizes within its operating range...

Basic Body Size "UC" Casing Slips....	**13⅜"**	**10¾"**	**9"***
Interchangeable liners available to fit.....	**13⅜"** **11¾"**	**10¾"** **9⅝"**	**9"** **8⅝"** **7⅝"**

**Fits bore and taper of standard rotary table.*

LINERS EASILY REPLACED

The liners in "UC" Casing Slips have ample length and are so designed that they will cut through pipe scale and any surface coating on the casing to take a firm, slip-proof grip *without damaging the surface of the casing itself.*

And if at any time after long usage, the liners become dull—or when changing from one casing size to another as outlined above—they can be quickly and inexpensively replaced. Simply pull a stainless steel pin, replace the old liner with a new one, slide the pin back in place and the job is done. The stainless steel pins eliminate risk of corrosion and assure easy liner replacements. Furthermore, it is important to note that none of the load of supporting the casing string is placed on retaining pins, bolts or any other parts that can become sheared or lost in the hole. *For maximum safety and strength all weight on the liners is transferred directly to the Slip body itself!*

HERE IS WHY *every casing job needs the protection of Baash-Ross "UC" Casing Slips!*

Because casing has a thin wall in relation to its diameter, it is easily crimped or damaged by even small misalignments that would not affect thicker-walled drill pipe or tubing.

If casing diameters vary slightly or if the slips are not set at exactly the same level, conventional rigid-type slips cause concentrated slip pressure that can crimp, bottle-neck or squeeze the casing out-of-round.

Such damage not only risks dropping the casing string, but the bulged or egg-shaped areas can cause poor joint make-up as well as tight spots through which tools cannot pass. Moreover, wear concentrated on the bulged spot leads to premature casing failures.

The flexible unitized design of Baash-Ross Type "UC" Casing Slips eliminates risk of one portion setting higher or lower than the other... and the multiple narrow segments assure an accurate, safe grip that exactly fits the curvature of the casing.

RESULT—there is no concentrated slip pressure—no misalignment of slip segments—no risk of damaging the thin walls of even the longest and heaviest casing strings!

Type "UC" Casing Slips are light, compact and easy for the crew to handle on even the longest and heaviest casing jobs. And they are so inexpensive that every casing job you run can have the protection of this new slip advancement. Your nearest Baash-Ross representative will be glad to supply full details... or write direct.

Challenge to the corrosion engineer*

By **H. H. ANDERSON,** *Vice President,* Shell Pipe Line Corporation

WHEN assigned to speak about "The Challenge to the Corrosion Engineer" I asked your program chairman—"To just what challenge do you refer?" He said—"You'll have to figure that out yourself!" So here I am, on my feet, aiming to discuss *your* business. I am a manager and not a corrosion engineer, so I only know about corrosion what I see in our profit-and-loss statements and in your published articles, so please excuse me if I quote from the latter profusely and loosely. Because of my Correlating Committee interest I intend to talk mostly to the cathodic protectors among you.

In the March issue of *Corrosion,* Dr. Fontana of Ohio State says that corrosion problems can be solved by 25 per cent data, 50 per cent experience, and 25 per cent just plain old-fashioned horse-sense. I accept that, because the doctor boasts of 15 years in corrosion work. But in just so many words he has shaken my illusion that you are scientists! If I can shake yours, all of us then can unbeetle our brows and take off our false whiskers.

As I see it, at least in cathodic protection work your group is faced with three problems. The first is to reconcile your techniques and the conflict of thought among your authors. The second is to get a lot more data on the extent and cost of corrosion, with comparative data on the effects and costs of preventive measures. The third is to do a better job of selling top management on how bad industry needs your services. To my layman's mind those three problems comprise quite a challenge!

Let's look at problem one. My expert —I say "expert" because those who have the urge to burst into print must feel that they are authorities—well, anyhow, my author tells me that the trick in cathodic protection is to build a film of hydrogen on the buried metal to shield it from attack by the soil moisture. Yet in a recent trade journal another "expert" has written that oxygen diffuses up to the originally anodic surface to form an oxide film as exists on the cathodic areas and thus prevents moisture from coming in contact with the buried metal. Those conflicting statements sound to me like confusion amongst the workmen in the temple!

In Bureau of Mines Circular 450 are reported comparative tests at the same place of three accepted criteria of protective current requirements. I quote loosely—"The null method first showed 3 amperes were required, but a second test showed 2.5; the pipe-to-soil potential method in one arrangement showed 18 amperes and in another 30; while a system already installed by a consultant was furnishing 0.1 amperes for the job." That may be an extreme case, but Dr. Logan recited it. More confusion amongst the workmen, say I!

With what superb restraint Dr. Fontana declined to add a few per cent of *science* to his prescription for the solution of corrosion problems. Such confusion amongst you surely needs your concerted best effort to correct. Thus, I commend to your association as project one the speedy reconciliation of such conflicting views and of such variations in the results of accepted techniques.

How about problem two? Even the best engineers who enter young companies, or who must introduce new techniques to old companies, are handicapped by a dearth of recorded local experience and concise cost data respecting it. Relevant corrosion data may be lacking because of newness of the plant; although in older plants often no one saw fit to record leaks, commodity losses and other damages, or the costs of same and of resultant repair and preventive jobs.

In corrosion work you need not only leak and damage experience data to diagnose the bad condition and to prescribe the cure, but also you need comparative cost data to prove its dollar payout. Many of you have too little strictly local data at hand, especially the "before and after" kind needed to prove that preventive measures are good economy. To get that needed data you are in Andy Brown's "picklement." Either you must waste years pioneering in your own backyard, or you must trade-rat the data from more fortunate colleagues. Thus I commend to your association as project two the collecting, compiling, and issuing of all available (and reliable) data of this type for your common use.

That brings us to problem three, selling the boss. That problem, though common, is a strictly personal one. Let me reminisce aloud. Thirty years ago I was among a group of youngsters in the California oilfields trying to sell engineering to management. A warm friend, Norman Hendershot by name and a dean of the old school of oil-well supply salesmen, often said to me—"Hal, there are just two hybrids that have no place in industry; one is a salesman who poses as an engineer, and the other is an engineer who poses as a salesman!"

Ten years later I gave that statement more thought. I saw that many college men had since been trained by manufacturers and sent into the field to sell. The "know-how" of these youngsters in time replaced the blind faith of the older salesmen in their goods and their uncanny sense of timing and buyer psychology. Perhaps there still was no place for a salesman who posed as an engineer, but it was crystal clear that the salesmen with sound engineering training and real knowledge of product application were welcomed by the customers.

And what of my technical pals that were going to needle the oil business? Alas, far too many of them were plodding away as surveyors, draftsmen, computers, and testers. I feel sure that this was due not to lack of ambition but to lack of salesmanship. There still perhaps was no place for an engineer who posed as a salesman but, believe me, the "engineers" who had outstripped the mere "technical graduates" were those who had enough salesmanship to convince the boss of the value of their professional techniques.

What is to blame for the lack of salesmanship among engineering graduates? First is the failure of the colleges to stress that facility in oral and written self-expression, and a working knowledge of economics, are *musts* for the successful engineer. Also we note the aversion of the students to acquiring these needed tools of their trade. What a pity so many of us hated English I and Economics I. And, later, we observe the failure of these same students as employes to recognize in hard-headed business that making money is really more important than advancing science—unless that science will pay dividends.

Archimedes said, "Give me a lever and I will move the world." The engineer who hopes to move his boss to action must use the compelling force of the "economic motive," and he will find that he can apply this to best advantage with a simple explanation. As a motto for business success I recommend — "I would rather have one good idea, and be able to sell it, than have five ideas I can't sell."

This gets me down to the subject of "gobbledygook," which is Congressman Maverick's name for the habit of writing in a clumsy or complicated manner that confuses the reader if not the writer. Some printed corrosion articles reek of

*Presented at Annual Conference, National Association of Corrosion Engineers, April 7, 1947, at Chicago, Illinois.

†Vice president and general manager, Shell Pipe Line Corporation, Houston, Texas, and Chairman, Correlating Committee on Cathodic Protection, National Association of Corrosion Engineers.

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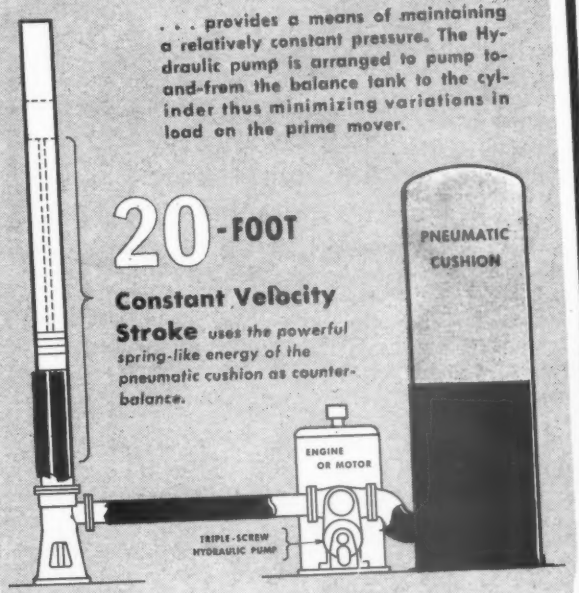
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such writing, and I'll bet much of the stuff written for the boss is just as bad. That's why the boss isn't sold. If he has the patience to read it he probably can't understand it.

I tried to read one article on the economics of coating and cathodic protection. I spent three hours trying to decipher one and one-half pages, and wasn't sure then whether I understood. For instance, referring to cost comparisons I read—"This general statement must, of course, be modified by (1) a consideration of whatever value may be assigned to the contribution toward the maintenance of continuous service which will result from the use of some form of protection, and by (2) a consideration of the expected capital losses which may be suffered by a diminution in the service capacity of steel pipe as a result of accrued but unrealized depreciation which it is anticipated that the protection would mitigate."

Couldn't the writer as well have said: "Such costs for the protected lines must include (1) credits expected from fewer service interruptions and (2) losses, if any, expected from diminished service capacity"? Or perhaps that isn't what he meant. I had the same trouble with the rest of the page and a half. Maybe I should try to paraphrase Einstein!

A recent trade journal article purported to give the first principles of corrosion. The title I could sábe, but the several pages contained sketches of potfuls of boiling chemical symbols as confusing as the illustrations in Dante's Inferno. In another article I ran across this advice: "Under these circumstances it is necessary for the investigator to juggle his thinking in order to picture himself at times outside a battery, inside a battery, or halfway in and halfway out." They say vaudeville is dead, but at that stage I would advise the befuddled investigator to juggle his Shepard Canes!

Writing and talking in such fashion is an engineer's own worst enemy in dealing with his boss. It's worse than B-O because a mere Lifebouy bath can't cure it. To those who have that habit I strongly urge the purchase and reading of two books, both of which to all of you will prove as fascinating as they are instructive. They are: "Technical Writing" by T. A. Rickard (John Wiley & Sons), and "The Art of Plain Talk" by Rudolf Flesch (Harper & Bros.).

It's only fair now to say that I've also found a lot of very well-written articles. A particularly fine specimen is the one by Mears and Brown in the March issue of *Corrosion*. Yes sirree, I could understand that one even without asking Mr. Mudd to explain it.

As chairman of the newly-organized Correlating Committee on Cathodic Protection, I've been trying to write a short simple article for top management. Its title is "Our Billion-Dollar Side-Show." If you will allow me eight minutes to read that effort to you, it will serve two purposes: First, it will let me show you a style that I feel is about as heavy as the boss will read. Second, it will let me get the article into print so as to tell the story of cathodic protection to management. If it will thus accomplish its purpose, I then can feel I have given you real help with the most personal of the many problems which confront you.

Our billion-dollar side-show

For Managers Only

(Reading Time: 8 Minutes)

Cathodic protection is deemed so important that eight industry associations, the two nation-wide communications systems and a professional association recently joined their efforts in a committee to inform managers about it, to promote cooperation within and between industries in applying it, and to aid the local solution of its technical problems. This work will take time. Thus, as Chairman of the Correlating Committee on Cathodic Protection, I am presuming personally to "jump the gun" with this direct appeal to management for understanding and cooperation.

(Signed)
H. H. ANDERSON, Vice President, Shell Pipe Line Corporation.

● **Out of sight, out of mind.** When Mike Jacobs can draw a million-dollar gate at the Stadium for a one-round main event, we concede that Barnum was right. But what about us in industry who are needlessly paying billions† for a show we can't even see? I refer to soil corrosion—Nature's relentless attack on our buried pipe lines, power and communications cables, rail systems and other metal structures. And I say "needlessly" because much of the damage can be stopped by cathodic protection if we will appreciate and supply this simple principle disclosed by Sir Humphrey Davy in 1824!

● **A speaking acquaintance.** Cathodic protection can save industry from myriad costly service breakdowns, commodity losses, customer ill-will, and plant repairs and renewals. Yet many corrosion engineers tell me that a prime limitation on its use is that management is not yet sold on it. These ardent exponents know how simply it works, how great is its value, how tangible is its economy, and how it warrants broader acceptance. Thus I suspect many engineers have confused instead of enlightened the boss with too much detail while trying to explain facts that seem obvious to them. Believing that every operating executive owes it to his business to be at least on speaking terms with cathodic protection, I beg to introduce you herewith.

† According to Bureau of Standards Circular C-450, the annual cost of pipe line replacements due to corrosion is approximately 200 million dollars per year! This does not take into account the costs of replacing various other types of plant suffering from soil corrosion.

● **Dust thou art.** Let's raise the iron curtain on this billon-dollar show. We started it ourselves when we buried our refined metal structure bare (or practically so) in the soil. This upset Mother Nature's age-old chemical balance, and the old Dame promptly started soil corrosion at work to restore it. Soil corrosion of metal is caused by a localized attack of soil chemical solutions. It starts where the soil is more moist and acid or alkaline than average, or it can start at a defect in the metal surface. It generates electric currents which flow from the point of attack out through the soil back elsewhere to the metal.

● **Assault and battery.** You recall that in a common battery the solution attacks the zinc or baser metal, called the "anode," to generate a current. This current flows out through the solution to the carbon, called the "cathode," thence through a metallic circuit back to the anode. And what of our buried structure? Contacted by the varying soil solutions of Nature, its bare surface serves both as anode (the area under attack) and as cathode (the rest of its surface) because its metallic continuity forms a circuit between them. As shown in Fig. 1, if our structure is long (or is of large area) it can be a part of many such natural batteries, and thus it can have a series of anodic and cathodic sections.

● **Jekyll and Hyde.** Soil moisture, that well-known H_2O, plays a dual role in our subterranean melodrama. Fig. 2 shows a molecule at work! During the chemical attack some of the water divides into hydrogen and oxygen, each going its separate way. Oxygen is the one that attacks our structure. Its corrosion atoms create an anode, which responds with a weak but determined electric force that sends currents out through the soil seeking a cathode. But hydrogen rushes to the rescue. Its atoms ride the currents through the soil and cover the rest of the bare surface. Soil chemicals cannot pierce the hydrogen film, thus it shields all but the immediate area under attack; i.e., it protects the metal by forming a cathode. Eureka! There's a clue to cathodic protection. If we can cover *all* of the surface with enough hydrogen we may protect it completely.

● **The sacrifice.** And how is this to be done? As they say in the movies, we merely get a "stand-in" or a substitute anode. Through it we can apply other currents strong enough to enter our structure's entire surface via the soil, thus overpowering and reversing the local battery currents trying to leave. The simplest way to protect a *steel* or *lead* structure is to merely bury a chunk of baser metal (such as magnesium, alu-

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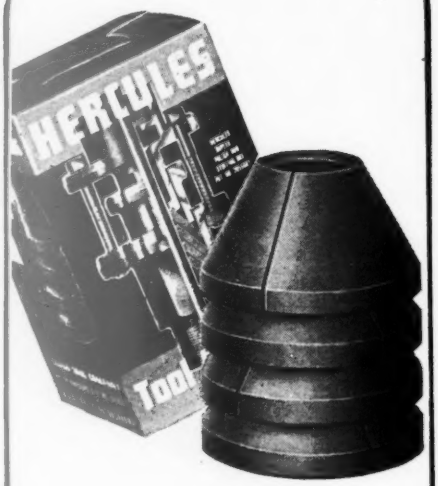

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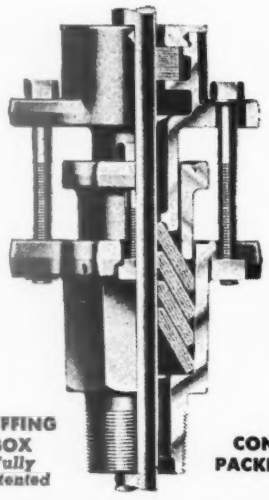

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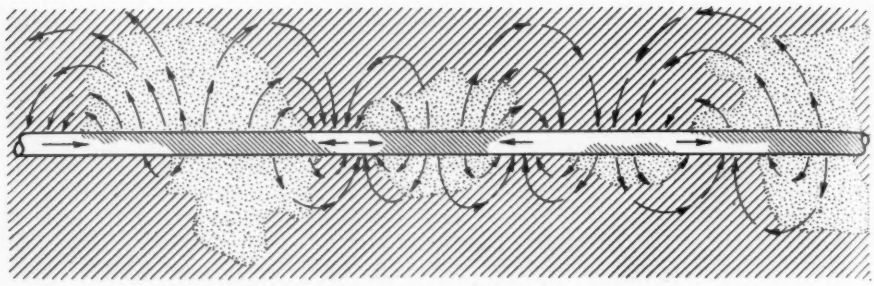


FIG. 1. Series of batteries caused by attack of patches of sour or moist soils along a structure. Arrows show currents flowing from anodic areas (areas of attack) to cathodic areas.

minum or zinc) near the structure, and connect the two by an insulated wire. Oxygen has a greater affinity for this baser metal, so—as long as the two are connected by the wire—it instead attacks the baser metal! This responds more vigorously and forces much stronger currents out through the soil en route to our structure. As shown in Fig. 3, hydrogen again rides them all and makes a cathode of its entire surface—even the areas before under attack. The currents return from the structure to the baser metal anode through the wire. In the process, the baser metal instead of our structure is slowly oxidized or corroded away. Biblically speaking, it lays down its life for a friend. That's why we call it a sacrificial (or "galvanic") anode.

● **A knock-out punch.** Some soils are so corrosive as to require stronger measures. Here we may bury a mass of junk iron or steel (or a carbon rod) nearby to serve as the anode. Then with insulated wires we connect a strong external direct-current source, such as a 10-volt generator or rectifier, (+) to the junk and (—) to the structure. The generated currents force their way from the junk anode through the soil into the structure and smother it with hydrogen. The junk will be eaten away in time and must be replaced. A single such unit, being ten times more powerful than a galvanic anode, can protect several miles of structure under some conditions. The choice of a current-supply in each case poses some nice problems, not only in meeting the need but also in the balancing of first costs versus recurring expenses.

● **Rags and tatters.** Our buried structure can be protected also with special enamels or coatings. But only during the last few years have we learned how to apply these properly. There's many a mile (and acre) of structure with defective coatings; and these may be worse than none because such defects act to focus corrosion and localize pitting. What are we to do about them? The cold sod is a poor and expensive place in which to apply new coatings, anyhow. Thus, if our structure's present coat is tattered, cathodic protection may provide safety with economy.

● **They hide the body.** When installing new metal structures, many shrewd operators know that a modern enamel coating, properly applied, plus *some* cathodic protection is best economy in the long run. They never can infallibly predict the soil action along a new route, and they know it costs about five times as much to later dig up, clean, repair and coat a line than to coat it right in the first place. They know also that a bare metal structure must be extra thick to allow for corrosion pitting, and that this extra metal costs about as much as a good coating. But even the best of coatings may develop defects (either while being buried or later); so a light supply of hydrogen should be on guard to fill the holes. Thus *some* cathodic protection is good insurance even on a newly-coated line.

● **At the crossroads.** It looks as if that should end our troubles, but no. For better or worse, every current must flow back to its source. If a neighbor's metal structure is adjacent, or if it crosses but does not touch ours, and it is within the field of the currents flowing from our protective anodes to our structure, some of the generated current may possibly "stray" into his structure (which provides a low-resistance path) and flow through it to the point nearest ours. There the current must leave his structure to jump through the soil back into ours and return to its source. We saw before that chemical attack on metal will cause current flow. Well, it also works in reverse! Where our stray current leaves his structure to enter the soil, it may cause chemical attack or local corrosion. This action is called "electrolysis."

● **Out of the pit.** Electrolysis can be as bad as true soil corrosion because, with either one, a current flow of one ampere in a year will destroy 20 lb of steel or iron, or 75 lb of lead. And both usually focus to cause pit-holes which soon pierce our structure. Electrolysis can be avoided by connecting a resistant wire or "bond" between the two structures to drain the returning stray current from the adjacent structure into the pro-

FIG. 2

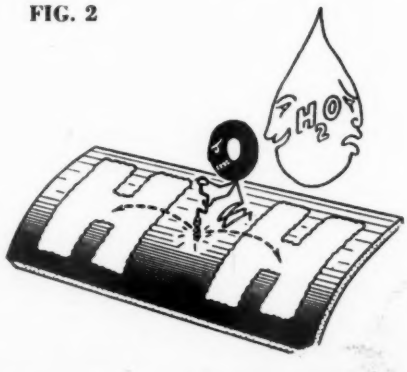
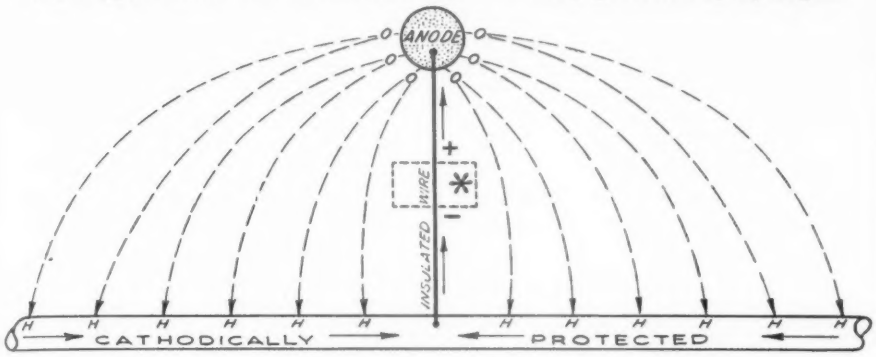


FIG. 3. Long structure showing currents from buried anode entering structure. All oxygen attack is at anode. Structure is entirely protected by hydrogen.



*Generator may be placed here if galvanic anode is not used.

tected one. This "drainage bond" must be well-designed, however, because too little drainage will not stop the interference, while too much will give our neighbor real cathodic protection at our expense. We want to be friends, don't we—but not philanthropists! It was said above that a good coating reduces the current needed to cathodically protect our structure. The lesser current, in turn, reduces the chance for electrolysis to occur!

● **City slickers.** Strong stray currents from electric railway tracks have long caused electrolysis of other buried structures in cities. Several competent local committees have worked for years to minimize this action. With the steady conversion by transit companies to motorbus and double-trolley coach service, however, that trouble is abating through removal of its cause. Conversely, true soil corrosion is spreading in cities because removal of the stray currents allows the weaker currents of Nature's batteries to flow unopposed. Thus city operators, too, must increase their interest in cathodic protection.

● **The denouement.** If we want to use cathodic protection, we can ill-afford to interfere with neighboring structures by electrolysis. Yes, and our neighbors can ill-afford to have this done. But decorum tells us that our corrosion engineer should not trespass the other structures—even to make the tests needed to design the drainage bonds. If our neighbors also are acquainted with the problem and will cooperate for the common good, however, they will welcome the tests, the technical details can be readily worked out, the bonds can be installed and all structures will be benefited.

● **Quintessence.** Often we may want to install cathodic protection where a neighbor's structure parallels ours for a distance. Then his structure will absorb much of our precious current and need several drainage bonds merely to prevent interference. Here we often can save money by inducing him to install cathodic protection too. And why not, if his structure lies in the same corrosive soil? Several large companies have installed many protection units jointly. Capital as well as operating expenses are shared equitably, and with mutual satisfaction. Here, again, acquaintance with the general problem at the management level aids the engineers to work for maximum protection and economy. Such results help the customers, and please the stockholders!

● **Summing it up.** As the curtain drops on our show, we can take stock. Does cathodic protection work simply? In essence, yes; we just get a current source or anode and spray on a little hydrogen. Is its value great? Why not—if it stops the corrosion. Does it need a special kind of cooperation? It doesn't if we are all acquainted with its problems and will follow the Golden Rule. But what about its tangible economy? If you are not already sold, a good corrosion engineer probably can prescribe it for your own structures and soon convince you of its economy. But to stress my main point, you can see that cooperation with others in cathodic protection is good business.

● **They also serve.** The problems of cathodic protection aren't really as simple as I've made them seem. Their solutions call for data, science and experience mixed with plenty of plain horsesense. But our corrosion engineers will work them out for us and thereby lessen industry's heavy losses from soil corrosion to the extent that we afford them the opportunity and lend our sympathetic support!

● **Summary.** Summarizing my earlier remarks, I have proposed:

1. That you harmonize the apparent confusion amongst you.
   a. by reducing your techniques to common denominators, and
   b. by reaching agreement on terminology that may reconcile the differences between your written conclusions;
2. That you help each other by collecting, compiling and issuing available experience and cost data needed to prove that corrosion prevention is good economy; and
3. That you sell management on the value of your service to industry through the force of the economic motive applied with the power of simple explanation. That means more attention to costs and paycuts, and less use of technical jargon.

These proposals comprise a real challenge to the corrosion engineer. ★ ★ ★

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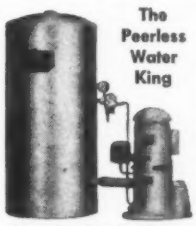

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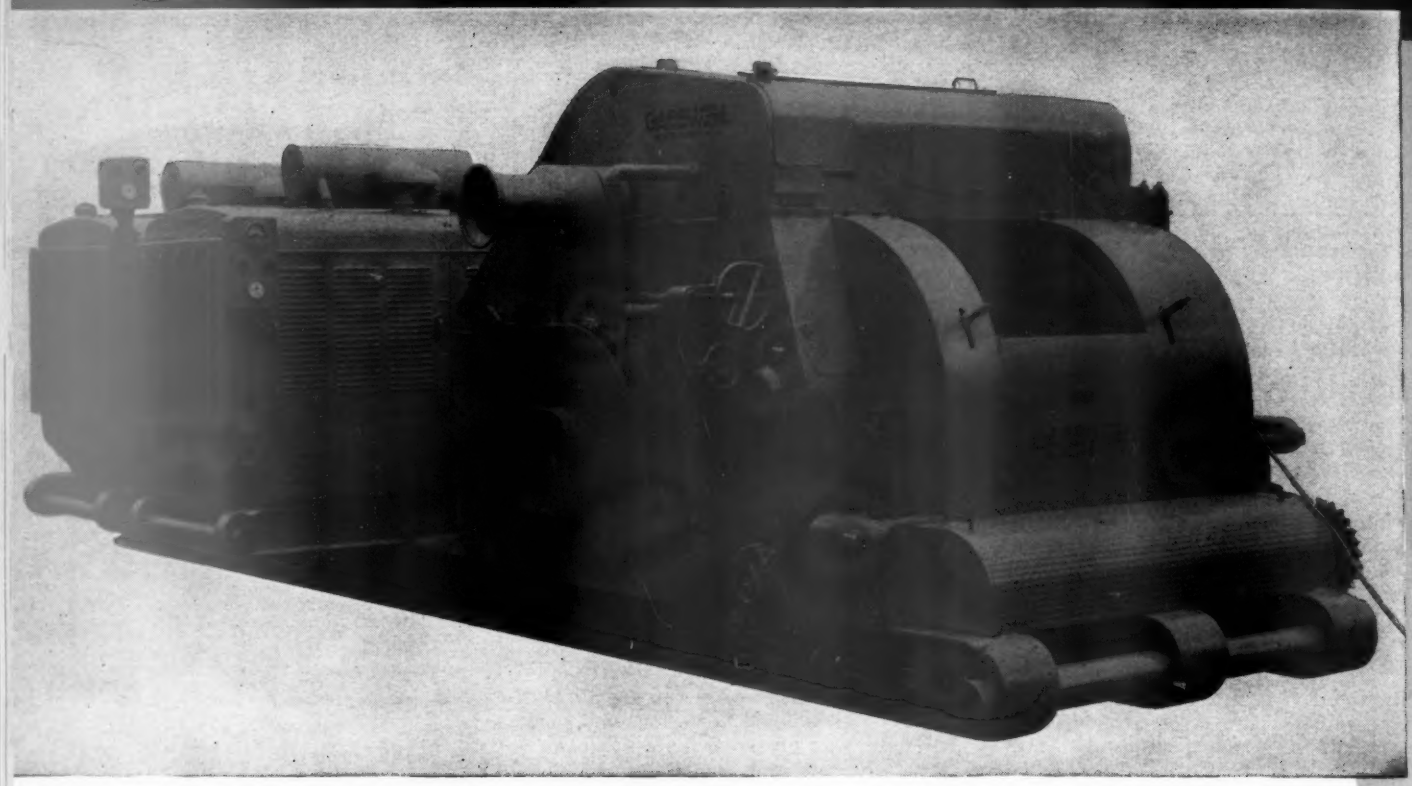

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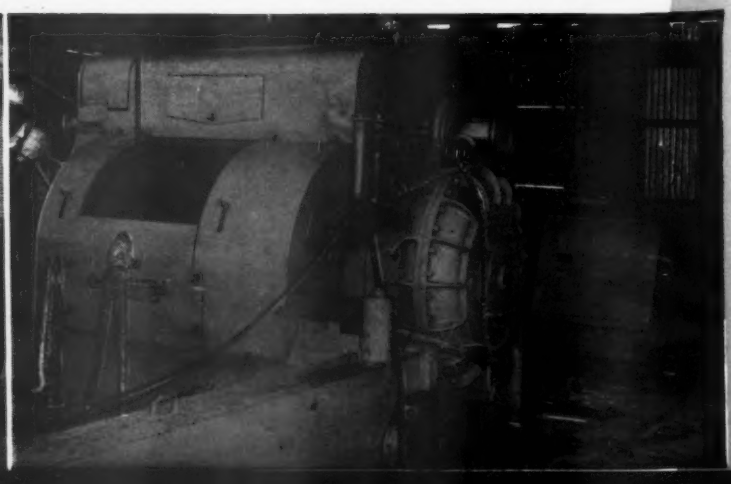

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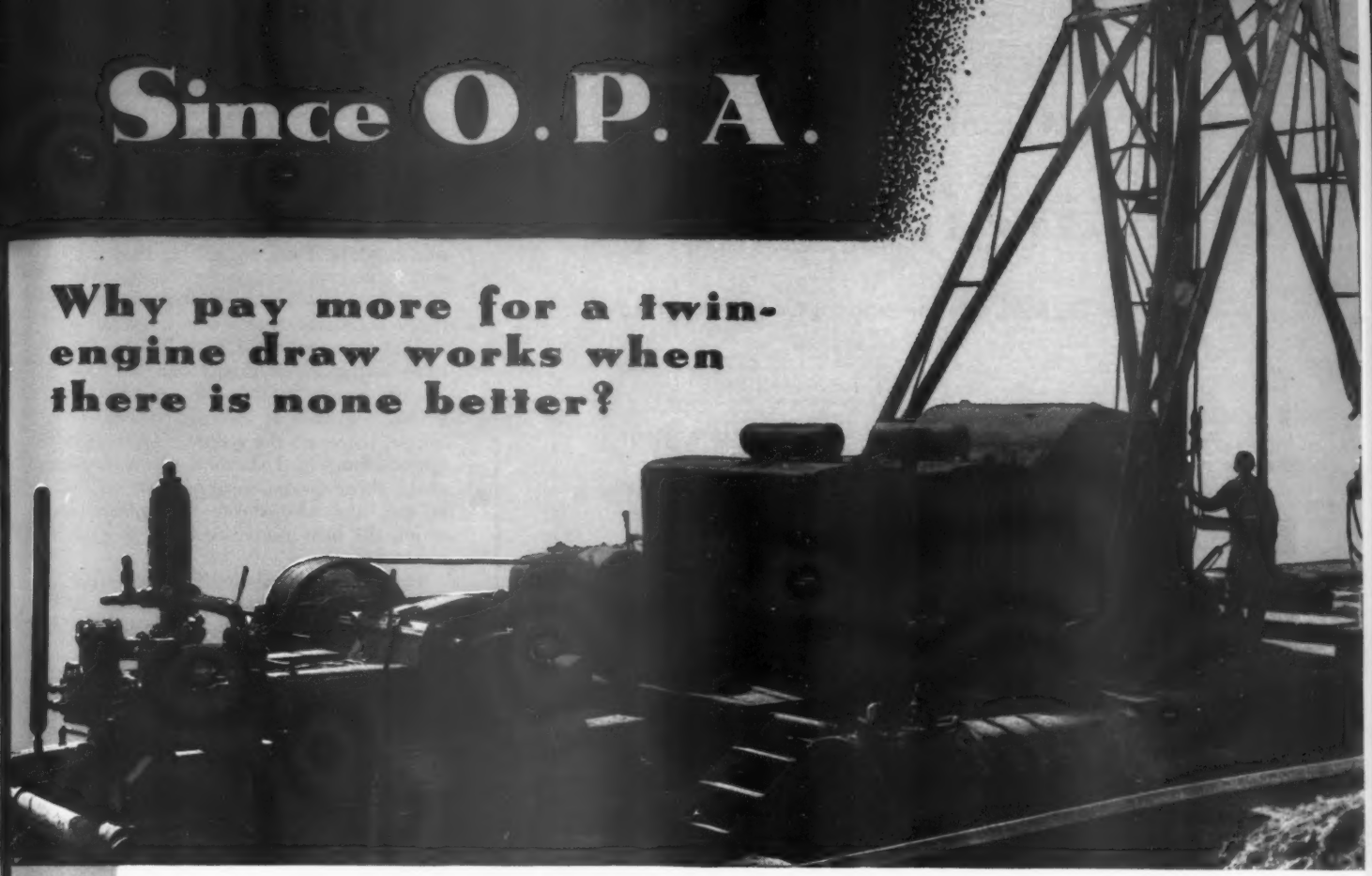

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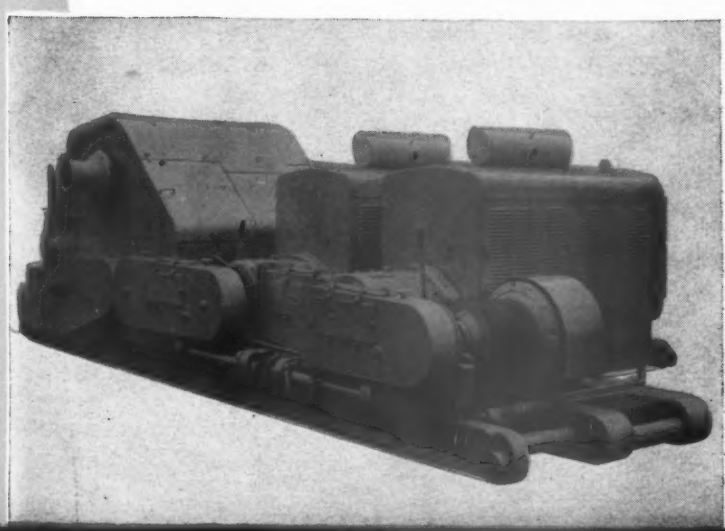

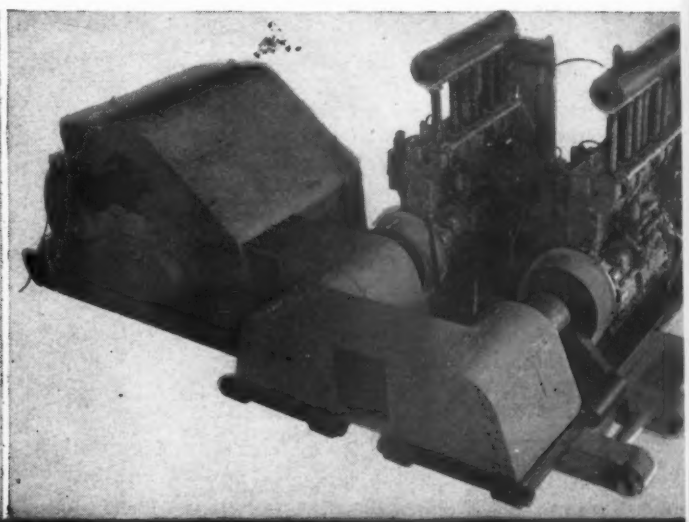

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Thermo-setting plastics effective in well repair

By **O. O. DALE,** International Cementers, Inc.

THE use of synthetic organic plastics for the exclusion of undesirable formations in oil wells is a quite logical development of the long established well cementing art, for, in actuality, the plastics used either in repair or remedial work, are cements in at least several of the more important meanings of the word: They can be molded into any desired shape; they do set in hard, solid, impermeable form, and they serve excellently the function of bonding agents.

EXCLUSIVE

It may be said properly, then, that the use of plastic resins is merely an extension of cementing practice. Indeed, the ramifications of well completion, the tighter segregation of producing formations in active wells, and all the methods by which sub-surface migration of oil to the hole is controlled, have excited a continuous study of the chemical characteristics and physical properties of Portland cement, so that its quality may now be varied to meet a wide range of operating conditions. This is especially true with respect to setting time and its relation to temperature, pressure, and other influencing factors.

Despite the advances that had been made in adapting the properties of Portland cement, and improving cementing techniques, a need has still been recognized for some type of plastic having totally different qualities. With the growth of the synthetic organic plastic industry, and petroleum's part in the provision of essential constituents, it became evident that the thermo-setting plastic resins had many inherent properties that would be advantageous in certain cementing operations, and that with adjustment in other respects, they could be used in such operations.

Working in conjunction with petroleum engineers, the Dow Chemical Company, and its subsidiary, Dowell Incorporated, have succeeded in manufacturing plastics carefully designed to set at the temperatures encountered in oil wells. For several years, these have been employed in the Mid-Continent to handle special cementing problems, and they have done so very satisfactorily in a large number of cases.

Although at the present time plastics are being used quite extensively in California for plugging services of various types, the prospective field for their application in remedial and repair work has barely been scratched. They have proved to be well adapted to a number of operations for which Portland cement lacks some of the prerequisites, and in others where the peculiar properties of the plastic make it better in all respects for the job at hand. The development of thermo-setting plastics especially designed for cementing off unwanted fluids in oil wells has been applied in California to the solution of many representative problems.

THE AUTHOR

O. O. Dale is now plastic supervisor of the California division of International Cementers, Inc. He has been continuously in the employ of this company and its predecessor, the Pacific Cementing Company, since 1936, having held various positions in the cementing and acidizing departments. From 1922 when he began his work in the industry until 1936, he worked for various companies in drilling and production work. The author has several inventions and improvements on oil field tools, which are in use today.

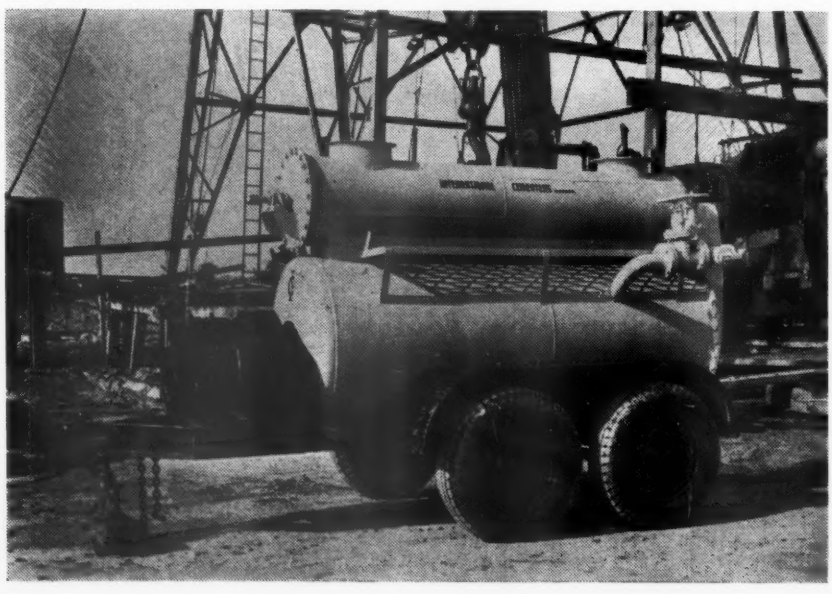
The plastic used is in the form of a liquid, which is polymerized to a solid by the influence of heat. When the prevailing temperature in the well at the point of application is insufficient to promote the action quickly enough, it may be speeded up by the introduction of a catalyst. Thus, the setting time can, within certain limits, be controlled. Plastics of this sort are now available in three variations that cover a range of temperatures from 70 F to 300 F. The fixed setting time of any one of these plastics can be modified to some extent by the addition of catalyst, which, of course, increases the scope of individual application. Fig. 1 shows the heat range of the three thermo-setting plastics now in use, and also shows the extent to which the heat range overlaps in each instance.

This type of plastic has inherent properties that are of distinct advantage in specific oil operations. It is a true homogeneous fluid, unlike Portland cement, which is a suspension of solids in water. It is largely inert chemically, and does not mix readily with oils or brines in the well. Such liquids, therefore, have little effect on its hardness, strength, and bonding quality. Because of its liquidity and homogeneity, it lends itself admirably to squeeze work, being easily forced into small interstitial cavities or fissures in the formation, where, incidentally, it does not tend to build a filter cake at the sand interface.

It has a specific gravity of approximately 1.2 at 60 F, and a viscosity comparable to that of a 30 SAE motor oil. When solidified, it is easily drilled with a chisel-bottomed bailer or portable rotary with tubing, and the drillings, like the original fluid, are inert, consequently have no effect on drilling fluids.

Colloidal drilling muds with a water base are inimical to the use of plastics,

This mixer is used to mix catalysts and/or filler materials with plastics, which are to be dumped into the well and displaced through tubing.



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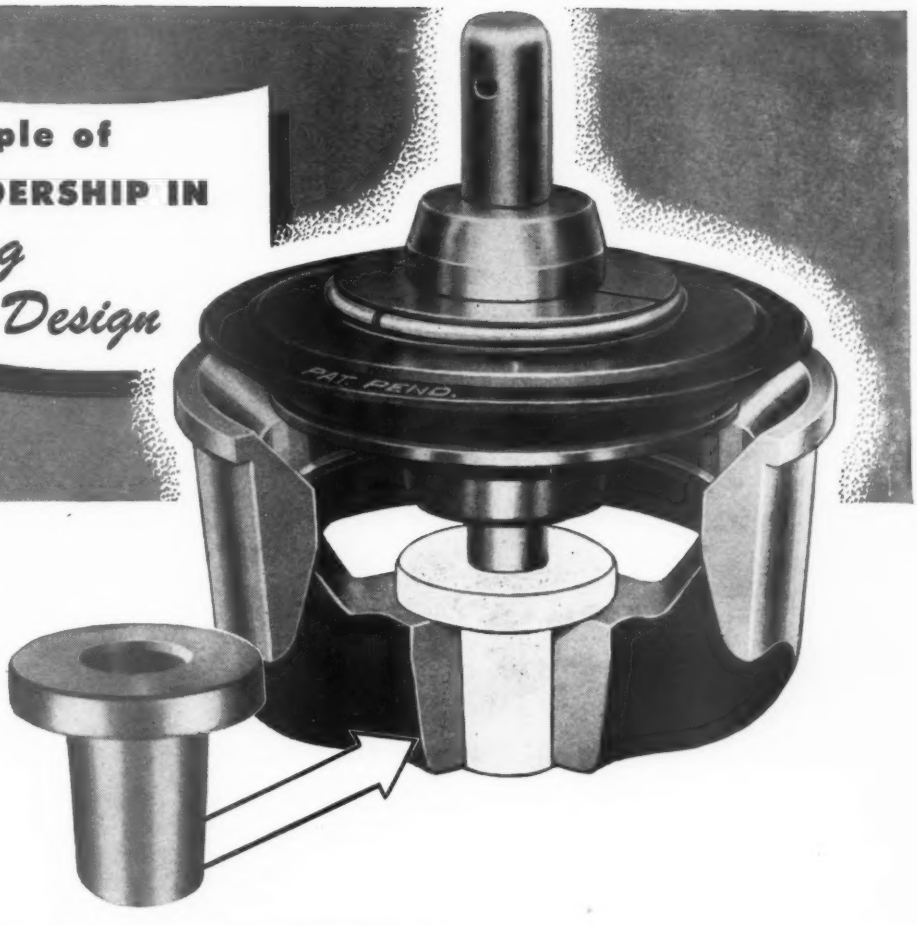

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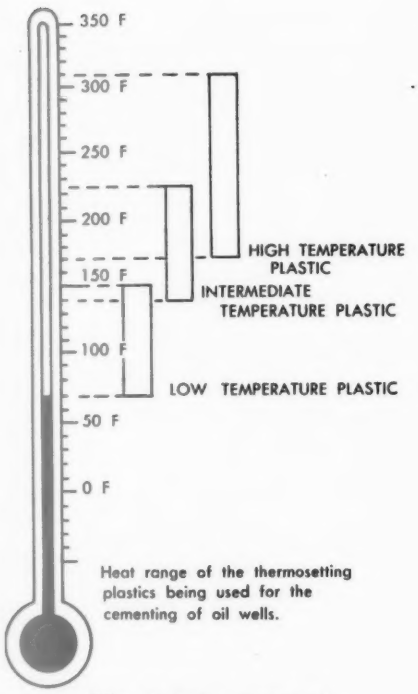


FIG. 1. Heat range of thermo-setting plastics.

for the latter do not bond to mud filter cake. They can, however, be set in the presence of rotary mud, but only under carefully controlled conditions, and with the exercise of very special precautions. Indeed, as the operator becomes more familiar with the qualities of thermo-setting plastics and their behavior under the various conditions imposed, he will recognize that he has come into possession of a new tool with great possibilities for the solution of many bothersome production problems.

Looking now at the *modus operandi*, there are three basic steps in the completion of a plastic plug: (1) Location of water entry, (2) preparation of the hole, and (3) placement of the plastic. The location of water entry obviously is highly important, for the proper placement of the plastic in relation to the point or points of entry is the secret of a successfully completed plug-off. There are several ways in which this may be contrived: (a) By the use of a so-called "water witch," or electric water-locating device, (b) by correlation of well data with that of neighboring wells, (c) by electric logging, and (d) by means of the permeability index. It is generally conceded that the most permeable part of a producing zone will yield its oil fastest, and if the oil is water-driven, may be expected to go to water first.

Besides the necessity of determining accurately the point of water entry so that it may be plugged off, there is also the necessity of accurate placement to avoid shutting off a producing zone. The importance of this primary step, thus, is paramount.

The preparation of a well, originally completed with mud, requires that the mud be cleaned away from the area in which the plastic is to be used, and from any adjacent areas whence it might migrate to the point of plugging, contaminating the plastic, and spoiling the job. If the plug is to be made through a perforated liner, the liner must be cleaned inside, the perforations opened or the liner reperforated, and the involved section of the annulus, including the face of the formation, freed of mud so that the plastic will bond tightly at the designated place.

It is possible, particularly when a well is producing from a thin oil section, and the rate of production is high, that the hole may be sufficiently clean. Such instances are rare in California fields, however, and practically always when a plugging job is contemplated in a well that has been drilled-in with mud, special measures are required to make sure that the mud is removed from the section in which the plastic is to be set.

If it is known before the well is completed that plastic remedial work is likely to be required later the completion process can be so modified as to provide almost ideal conditions for such work. The well, for example, may be drilled in with cable tools, where convenient. It may be drilled in with oil or oil-base mud. Washing with a circulation washer using water, preferably salt water, may be resorted to. Mud and mud filter cake may be broken down and removed by acidization or other means. Impermex or starch mud may be utilized and later disintegrated by bacterial or acid action. Any one of these methods, or a combination of two or more, may be adopted to eliminate considerable preparatory work when the subsequent use of thermo-setting plastics for the remedial or repair program has been decided upon.

By the same token, the forward-looking operator can take other steps during the well completion period to facilitate the application of plastic plugging at some future time, and that such steps are desirable from the standpoint of economy is unquestionable, for, that the need of a plastic plugging job will one day arise, is certain in a great many instances. The following methods of cleaning the well will tend to reduce later preparations for plastic application and add decidedly to its chances of success:

A—Bailer
B—Hydrostatic bailer
C—Hydrostatic bailer with perforation washer
D—Push-out type washer.
D—Suction washer
F—Circulation washer
G—Chemicals
H—Mechanical perforation opener.

When chemicals are used to clean the required section of the hole, they must be neutralized, or removed by a bailer or pump so that they will not affect the setting of the plastic. The cleaning of the well may at times present a difficult problem, requiring tedious application, but adequate preparation is vital to success and it is better to be cautious at this stage than to have regrets later. Poor jobs cannot be justified by any standard and it is infinitely better to spend a little extra money being sure that the preliminary part of the process has been done properly than to risk the entire investment by ignoring any one of the essentials.

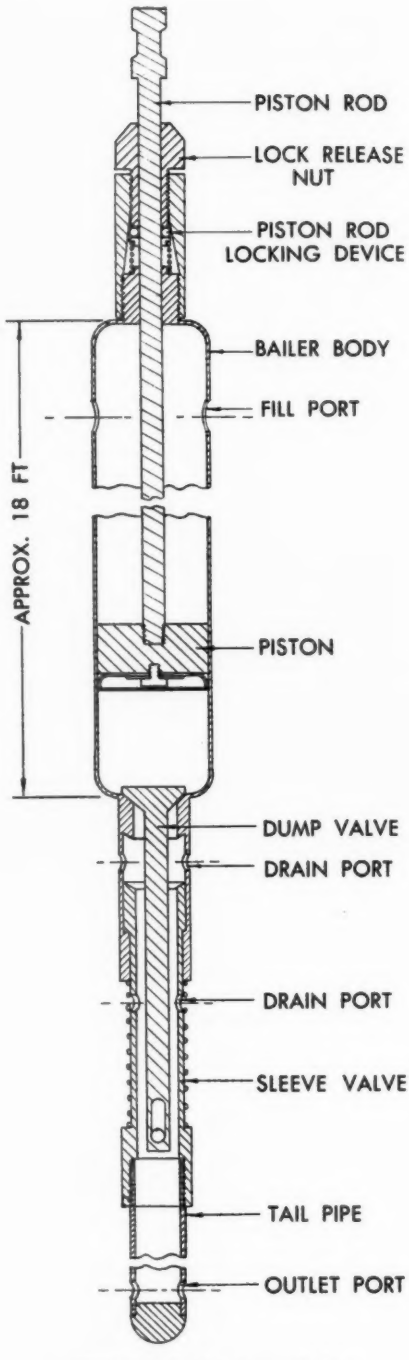
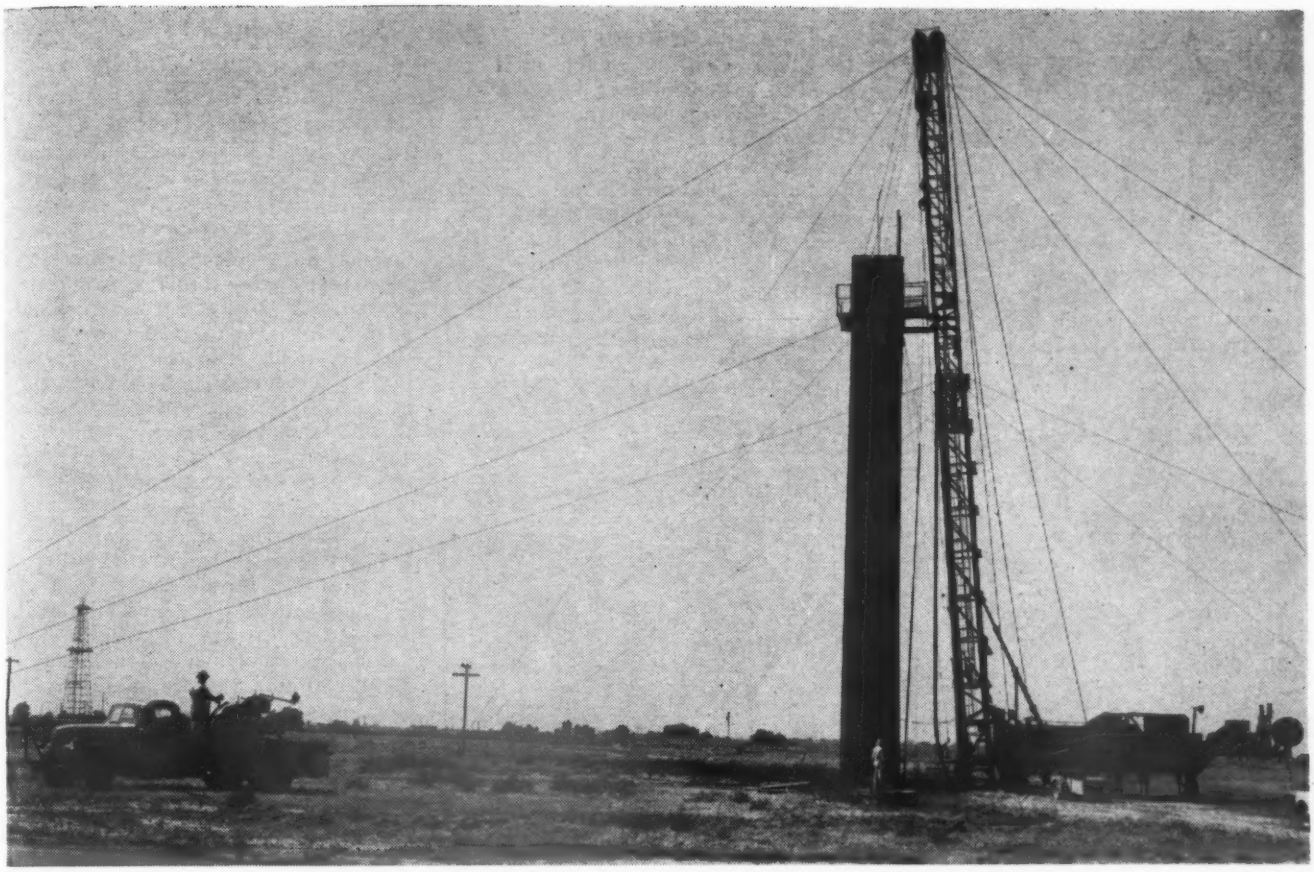


FIG. 2. Plastic dump bailer.

Before actually attempting to introduce the plastic, it is necessary that all fluids be at equilibrium, otherwise they may, in the course of migration, carry the plastic away from the critical area, and may even deposit it eventually at a place where its effect is harmful rather than helpful. There are two general methods of placement: (1) By means of



This view of a well being repaired was taken at Greeley, California, oil field, one of state's deepest oil fields—below 11,000 ft.

a positive displacement dump bailer on a wire line, (Fig. 2) or (2) by pumping and displacing through tubing. When the first method is used, the bailer is run in on a sand-line from a hoisting unit especially built for the job, and provided by the servicing company.

The bailer is designed to trip when it rests on bottom, the valve in the lower end remaining open so long as the bailer remains at rest on the floor of the hole. The fluid content is ejected by means of a piston attached to a rod of sufficient length to permit displacement of the entire quantity. If the section to be plugged off is above bottom, a new bottom is established by bridging back with sand or sand and gravel; or a regular bridging plug may be set in the liner or casing. To prevent loss of fluid plastic through permeation in a downward direction, a plastic seal may be placed on top of the bridge, such a seal being usually composed of normal plastic in which is incorporated a considerable quantity of filler.

When plastic impregnated with filler is used for sealing, there is formed at the sand interface, or in small fissures, a filter cake that is impervious to the liquid plastic. It is, however, interesting to note that varying proportions of filler and plastic in such media can be used to control the degree of penetration in sands of known permeability. The fillers in such cases form cakes by action very similar to that of drilling fluids. This, of course, is important when plugging through a productive zone, if it is planned to drill out the plastic later and produce the zone by perforation.

If the operation requires that a liner set through a productive zone be cemented with plastic, and later selectively gun perforated for production, fillers are employed for the dual purpose of keeping the plastic from permeating the sands beyond the limits reached by the gun-perforator bullets, and preventing possible loss of all the plastic into a sand of high permeability.

When plastic is to be used in squeeze work, fillers are essential, because the fluidity of the plastic enables it to be driven into low permeability sands with comparatively low drive pressures. The function of the filler, therefore, is to prevent the liquid plastic from channeling into the sand at the point of highest permeability. This it does by filtering out at the sand interface to form a cake that will not permit further passage of the plastic. Plastic that flows into the formation while this barrier is being deposited will set, as it has been designed to do, and the depth of its permeation into the sand will be determined by the quantity of liquid plastic that enters the sand face before the barrier becomes complete. It is obvious, thus, as previously explained, that experience eventually enables the operator, knowing the permeability of the section involved, to compound the correct admixture of liquid plastic and filler to obtain any predetermined degree of permeation by the plastic.

Placing the plastic by the bailer method is used effectively for the following operations: Plugging bottom in perforated casing, liner, or open hole. Selective plugging of a zone or zones, located off bottom, by bridging back with sand or a bridge plug, and so establishing a new bottom on which to dump the bailer. Repairing casing leaks resulting from split or otherwise ruptured casing, and repairing perforated liners in which the perforations have been enlarged to uneconomical proportions. Sealing packers or other types of bridge.

There are a number of operations that require plugging of the liner or the casing with a bridge plug at a distance from the bottom of the hole. Several species of such plugs are available, and sometimes it is expedient to use sand or sand and gravel in conjunction with the mechanical plug. When this is necessary, a special bailer is provided for placing the sand or gravel mixture accurately. One of the greatest advantages of the bailer method in remedial work is that it is comparatively simple and does not require heavy or expensive equipment.

If the pump method is employed, and plastic is placed through the tubing, the technique must be precise, for small volumes of plastic are the order, and they must not be contaminated by the circulating fluids in the well. The han-

dling has been facilitated by the development of new tools, and improvement in process, that together enable the proper placement of plastic without loss or admixture with undesirable materials. Solid rubber plugs are used to separate the plastic from the displacing medium, such plugs being equipped with multiple wiping lips that swab down the inner walls of the tubing as the charge descends, thus preventing loss by adsorption, and at the same time keeping the plastic from being fouled by other well fluids.

When the plastic is pumped through cement retainers, or other similar devices, a seat must be provided immediately above to catch the rubber plug. No change in existing equipment is required to do this, however, as there are already standard tools on the market that are adapted to the purpose. If the operator wishes to have an indication that the plug has actually been seated as planned, a constriction is made in the tubing just ahead of the seat. Extra pressure is then needed to force the plug through the constriction, and the extra gauge pressure developed denotes that the plug has reached the constricted area.

It may be pointed out that a wide diversity of remedial and repair jobs have been satisfactorily accomplished by the dump-bailer and tubing placement methods, and undoubtedly as further experience is gained in the use of thermo-setting plastics, their application to known problems will become more positive and more effective, and their application to presently unknown problems will be greatly expanded.

Phil Harris and Alice Faye, motion picture and radio stars, have abandoned their wildcat in the Texas coastal area, the No. 1 Hill Estate, three miles south of Evergreen. Walter Pidgeon, another Hollywood actor, backed a wildcat drilling near Abilene, Texas.

☆ ☆ ☆

A technique for consolidating loose sands, known as "sand consolidation," is being used successfully in the Gulf Coast area by Dowell Incorporated by the application of permeable plastic. This service has not yet been used in Califorina although it is available and appears to have a useful application in many areas. The plastic used for this service cements the loose sand grains together but does not materially reduce the effective permeability. Actually, the permeability may be reduced as much as 50 per cent but since sands of this nature usually have very high permeabilities, the productivity of the sand, after sand consolidation, has not been reduced more than 12 per cent in any instance known to the writer. Usually, the productivity of the sand is actually increased because the well can be produced with a greater differential pressure.

Summing up, the following facts have been established on the basis of data already available: The thermo-setting synthetic plastics that have been specifically designed for use in solving oil-well cementing problems, can be economically and beneficially used because of their peculiar characteristics. The fluidity of the plastics in their original form enables them to flow through perforations, and to enter sands, and when employed in squeeze work the required pressures are comparatively low. The plastics are not affected by oil, oil-base mud, water, or brines.

They have good bonding properties with adequate strength in the bond, and have the faculty of forming impervious solids with the sands they penetrate, so that a plugging job is not dependent on bonding solely. The fast setting time can effect a considerable saving of man-hours, and rig time, and, if necessary, the setting time may be extended to at least 12 hr. The techniques of placement have been so developed that repairs can be made with the minimum zone loss, and consequently little likelihood of deleteriously affecting the productivity of the well. In conclusion, an attractive feature of plastic plugging is that it can be applied and drilled out without resort to expensive, specially designed equipment.

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Fig. D393
Fig. D394
Fig. D395
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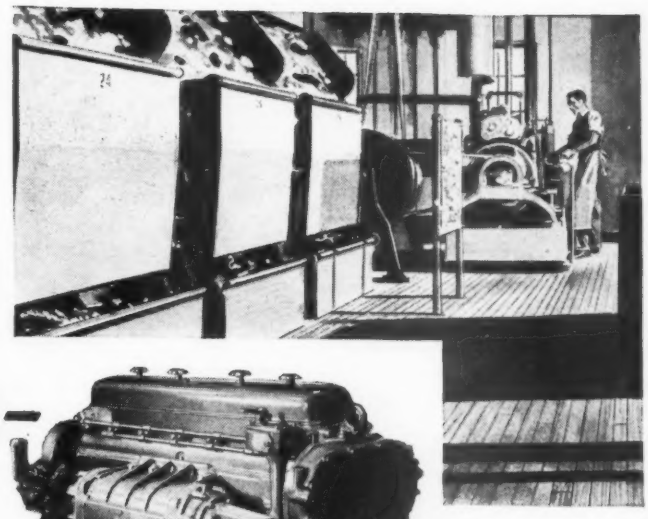

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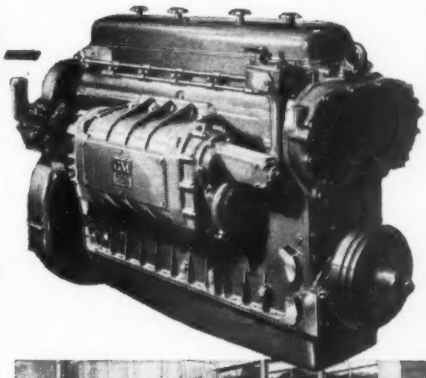

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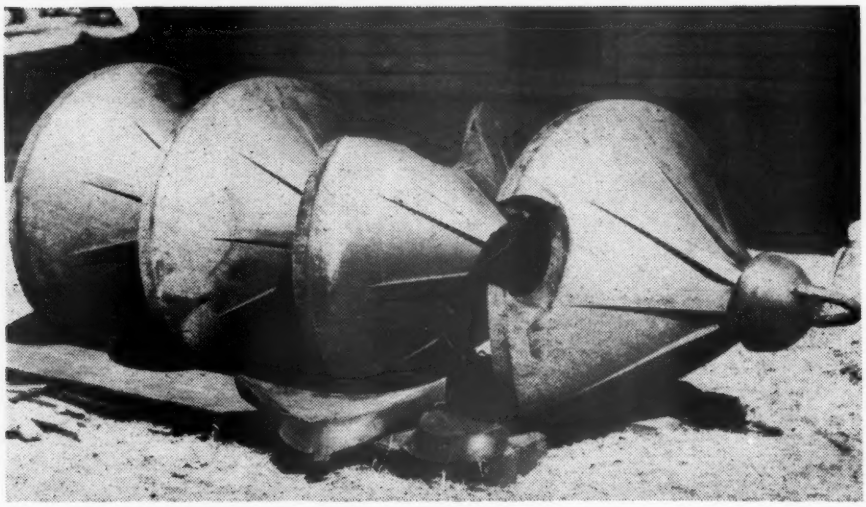


FIG. 1. This scraper passed through 25 miles of 26-in. pipe. Pieces were blown out as it passed 8-in. side outlet.

Experience with wax in the Stanpac line

EXCLUSIVE

WHEN wartime emergencies demanded the all-out production of gasoline early in 1942 the 26-in. Stanpac Line, jointly owned by Standard of California, Pacific Public Service Company, and Pacific Gas and Electric Company, was carrying natural gas from San Joaquin Valley oil fields to the San Francisco Bay area. Then, in June of that year, it was pressed into oil service for the duration of the war. It became the carrier of all light crude oils from the valley fields to refineries near San Francisco. Its operation as an oil carrier during the next four years is credited with making possible an unprecedented turnout of vital petroleum fuels at these refining centers by delivering some 185,000 bbl of crude a day. The route of the line is shown in Fig. 2.

In the summer of 1946 the Stanpac Line was relieved of its wartime duties, but its reconversion to its old job as a natural gas carrier posed a problem for the oil companies that had operated it during the war years. That problem was wax—a film deposited on the inner walls of the line's 26-in. pipe by the millions of barrels of waxy crudes that had been pumped through it since 1942.

The presence of wax in the line was definitely suspected when operating data showed that in the early summer of 1944 the line capacity had begun to decrease, the loss in capacity being uniformly distributed over the downstream 70 miles. This situation gradually corrected itself during the fall and winter months, but capacity loss was noted again during the spring and summer of 1945.

This rise and fall of capacity was at variance with previous experience with the same waxy crudes in smaller lines. These lines acquired wax deposits in the winter months and required scraping then, but little or no wax trouble was encountered in the summer. Moreover, the capacity reduction caused by wax in Stanpac was much greater than could have been caused by a wax coating of the thickness normally encountered. In fact, calculations indicated that if the roughness remained unchanged, a coating 1½-in. thick would be required to cause the flow reduction experienced. Displacement calculations, however, clearly proved that no such quantity of wax was present, and this was borne out by the subsequent wax removal operation, described in this article.

Explanation of the somewhat paradoxical behavior of Stanpac wax deposits from the seasonal standpoint and the evident high coefficient of roughness in summer have not yet been explained in quantitative terms to the thorough satisfaction of the engineers concerned with the problem. It now appears, however, that the wax was deposited on the pipe walls during the winter in the expected manner, and that the roughness coefficient increased greatly as the wax deposit gradually broke off the pipe wall in the early summer.

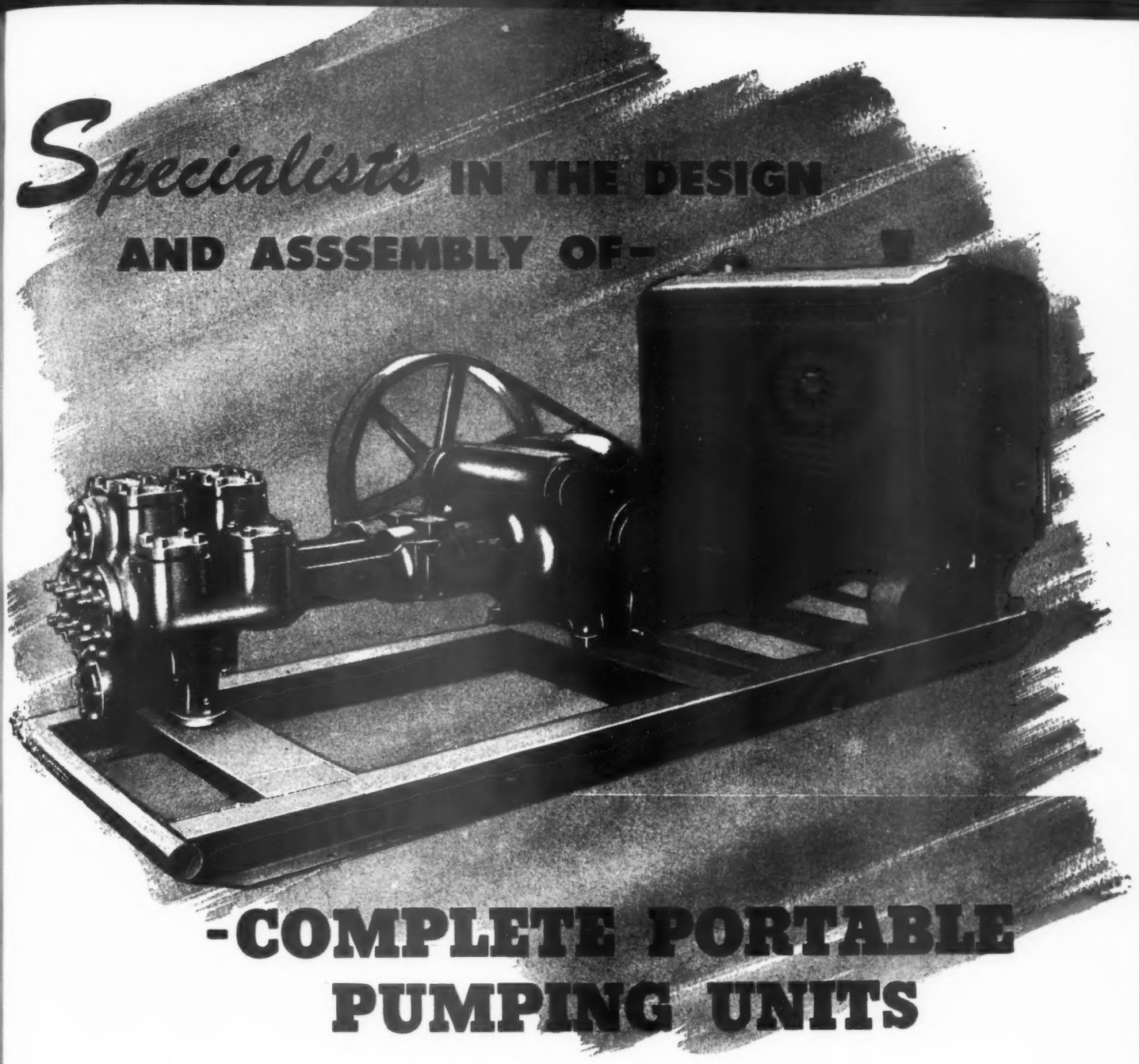
The removal of wax and cleaning of the line prior to its return to Standard Pacific Gas Line, Incorporated, for reconversion to gas service, presented some unusual and interesting problems.

The first step was to pump 70,000 bbl of gas oil through from Kettleman station, its southern terminus. This was not expected to dissolve any appreciable quantity of wax in the line, but was intended to clean out as much black oil as possible and prevent the formation of any heavy emulsions of crude and water that might later prove difficult to remove.

After the gas oil came two displacements of water, more than 1,000,000 bbl, which took six days to traverse the pipe line's length. Then Standard of California engineers, directing cleaning operations on the line, faced the problem of removal of the pipe's deposit of wax.

Ordinarily, it would be a relatively simple job to send a scraper through a pipe line, but this line was different. At 5-mile intervals most of the 26-in. line was equipped with 22-in. plug cocks with restricted throats through which no conventional type of scraper could pass and still effectively clean the larger diameter pipe. Removal of the valves was to be avoided if possible because of losses and damages. There were also mitre bends of unknown degree at various points as well as one 90-deg bypass.

Standard's engineers, however, had devised a 26-in. hollow cone type scraper that would pass through the restricted valve throats. Made of Buna N synthetic rubber, the scraper was developed with the aid of testing apparatus consisting of a joint of horizontal 26-in. pipe with a blind flange on the scraper entrance end and a 26-in. by 22-in. swage nipple and a 22-in. cock on the downstream end.



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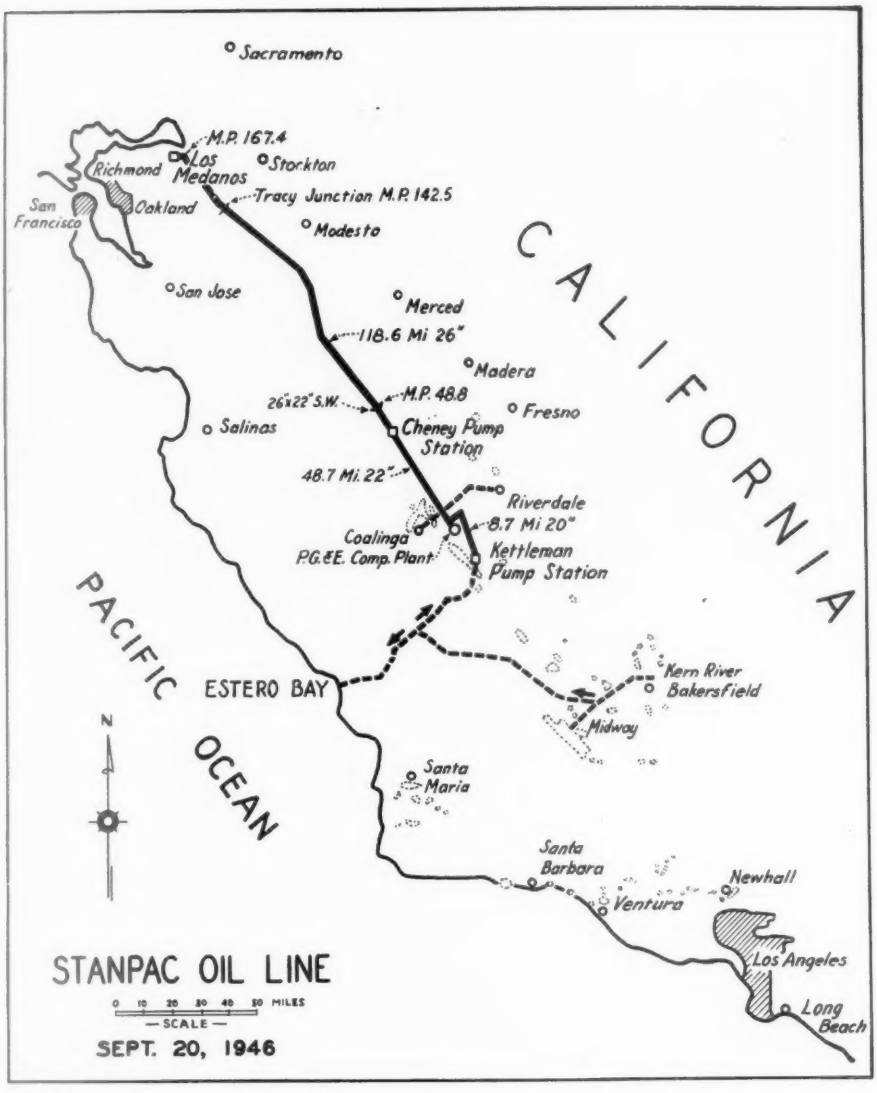

FIG. 2.

Water supplied from a 50-ft standpipe and connected at the bottom to the horizontal pipe behind the inserted scraper supplied test pressure through a 10-in. quick opening valve. After repeated trials a 26-in. scraper was devised that would pass through the restricted valve throats. This scraper is shown in Figs. 1 and 3.

As the first step in expulsion of the water now standing in the line, one of these rubber cone scrapers was inserted in the line near the southern end to maintain separation between the water and the following gas with which it was hoped to force all the water from the line at Los Medanos station, 167 miles downstream and the northern terminus of the line. The first 48 miles of the line was 22-in. pipe, in which the newly devised scraper would fit tightly enough to ensure a satisfactory separation of water and gas.

Gas was then admitted behind the scraper from Kettleman compressor station at about 350 psi, and the scraper traversed the first 25 miles without trouble at a rate of about 3 mph. Here it was found to be badly worn, and a new scraper was inserted that passed without incident into the 26-in. pipe at Milepost 48.8. Twice more before its arrival at Tracy Junction (Milepost 142.5) the scraper was removed from the line, and a new one inserted. During this run several mitre bends were passed successfully. The 90-deg bend at Tracy Junction was bypassed when the scraper was removed at that point. North of this point the scraper passed with increasing speed as the water load ahead decreased, and was clocked in one 4-mile stretch at 7 mph. Its arrival at Los Medanos was preceded by blows of a mixture of water, gas, and wax. The wax was not in the shape of a solid plug, but was carried ahead in suspension in the water. It was later roughly estimated that approximately 700 bbl of wax had been removed. The oil that came from the line with the last displacement of water ahead of the gas was almost negligible, probably not more than 50 bbl.

As a means of ejecting water ahead of the gas, for which purpose it was intended, the rubber cone scraper proved practically 100 per cent successful. On the other hand, later developments proved that the rubber cone type scraper had not been fully effective in removing wax from the 26-in. pipe.

Developments to this point established the fact that there was considerable wax left in the line, particularly in the downstream 70 miles. It was decided to proceed with a more intensive scraping program. Conventional oil-line scrapers in these large sizes were not available, but two different types of gas-line scrapers had been obtained. One consisted of two C-type rubber cups and two wire brushes on a structural steel framework about 2 ft long. The other scraper was made of one C-type rubber cup mounted in front and followed by two sets of cutter blades mounted on arms receding about 45 deg and held against the pipe walls by strong coil springs.

Before these two types of scraper were put into operation, each of the 22-in. cocks was removed from the 26-in. line, and lengths of 26-in pipe inserted in their places.

The first gas line type scraper to be run was a single scraper of the second type mentioned above, pushed through the first 10-mile section of pipe north of the Kettleman compressor plant. It brought out only about a bucketful of wax and dirt in small pieces. This was followed by a pair of scrapers of the same type, coupled together, and later by the wire brush type scraper (the first type mentioned above), all with similar negative results. The scrapers were propelled with gas pressure at speeds varying from 6 to as much as 45 mph.

To inspect the results of this initial effort, a Dresser-coupled purge joint was removed from a portion of the 10-mile section. It showed that the scraper cutters had removed the wax fairly well from the upper three quadrants of the pipe, but had dropped their cuttings on the lower quadrant. The C-shaped cups had not been successful in carrying these cuttings ahead. Instead they rolled part of the wax into loose chunks remaining on the bottom and had buttered part of it back on the lower quadrant. Most of these loose chunks, estimated at about 1 bbl per mile, were later removed by blowing with gas in about 2½-mile sections.

While continuing the scraping program with the available equipment, Standard's engineers devised another type of scraper that it was hoped would prove more effective. The new instrument consisted of synthetic rubber disks mounted on an 8-in. pipe shaft 42-in. long. The disks were 1¾ in. thick, and mounted in two gangs of five disks each, one at the front and one at the rear of the shaft. The disks were made of Buna N, totally impervious to oil and with a hardness of 50 points shore. (See Fig. 4)

Meanwhile, scraping operations continued on the central portion of the line. A pair of 26-in. scrapers of the second type were started on a 25-mile run from Tracy Junction (Milepost 142.5) to Los Medanos (Milepost 167). After running about 6 miles it was noted that the scrapers had a solid plug of wax, probably

Welding of A. P. I. Drill Pipe Joints

The following procedure is used extensively for the welding of standard A.P.I. drill pipe joints:

Both the pin end (male joint) and box end (female joint) are tightened in a lathe under 15,000 foot pounds. This assures a tight seating of the threads so as to secure their maximum strength. (Some producers who weld their joints in the field and do not have the necessary equipment for tightening the joints eliminate these operations.)

Pin End. One is shown being welded in Fig. 1. The procedure is outlined in Fig. 2. The coupling is welded to the pipe with ¼" "Fleetweld 5" electrode. This is a roll welding operation with the welding operator doing the rolling with his left hand. Both ends of the pipe are mounted on rollers to facilitate turning and the pipe is turned by the welder with a standard pipe turner with a handle about two feet long. Three passes are

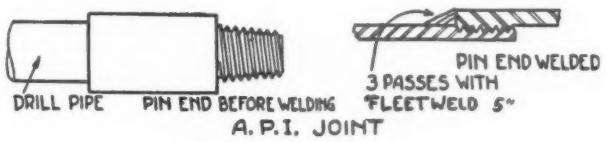

Fig. 2. Pin end procedure.

made, producing a bead which slopes down from the top of the coupling shoulder to the pipe at an angle of about 30 degrees. A completed weld is shown in Fig. 3.

Box end. It is shown in Fig. 4. Two beads are first made with "Fleetweld 5" electrode for strength purposes. A copper back-up clamp is then used to apply a wear-resisting shoulder with a flat face up to the level of the joint. This weld, made with "Wearweld" electrode, provides a hard flat surface which is desirable at this point because this is the point of contact with the elevator and is therefore the surface that must bear the entire load of the string below it, (when pulling out of hole). The back-up clamp shown in Fig. 5, is positioned between the clamp and the joint is filled up to the edge of the joint with

Fig. 1. Welding pin end of joint.

"Wearweld" electrode. This is a roll welding operation, the rolling performed by the welder.

Some shops preheat the joint to 600°-700° before welding.

Engineering assistance on the reclamation of tool joints and other welding problems may be obtained by contacting The Lincoln Electric Company, Dept. 423, Cleveland 1, Ohio.

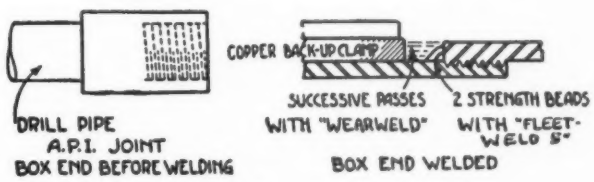

Fig. 4. Box end procedure.

Fig. 5. Copper back-up clamp for box end.

Fig. 3. Completed welds on pin ends.

Fig. 6. Completed welds on box ends.

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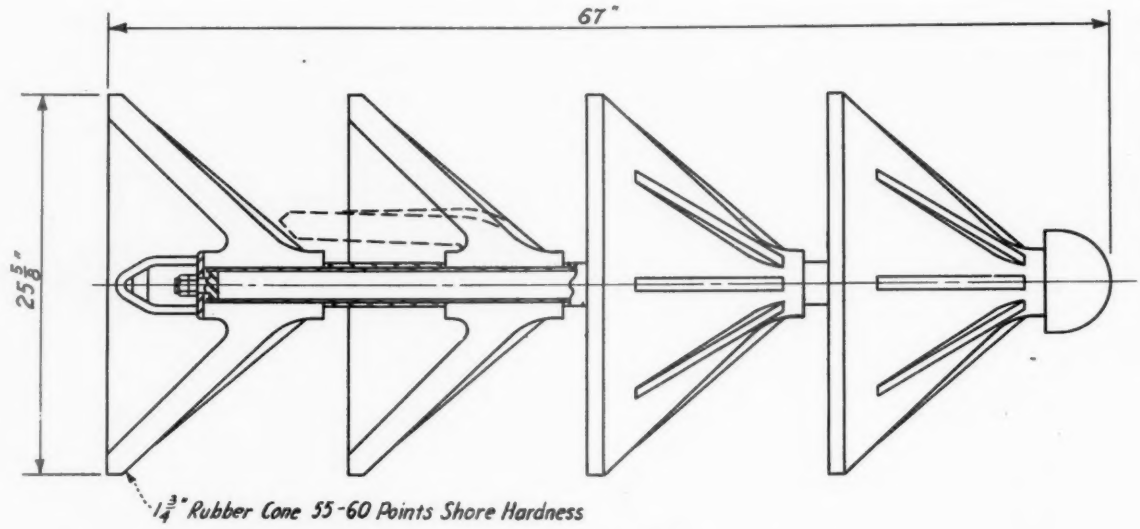

FIG. 3. Stanpac scraper, 26-in. hollow cone type.

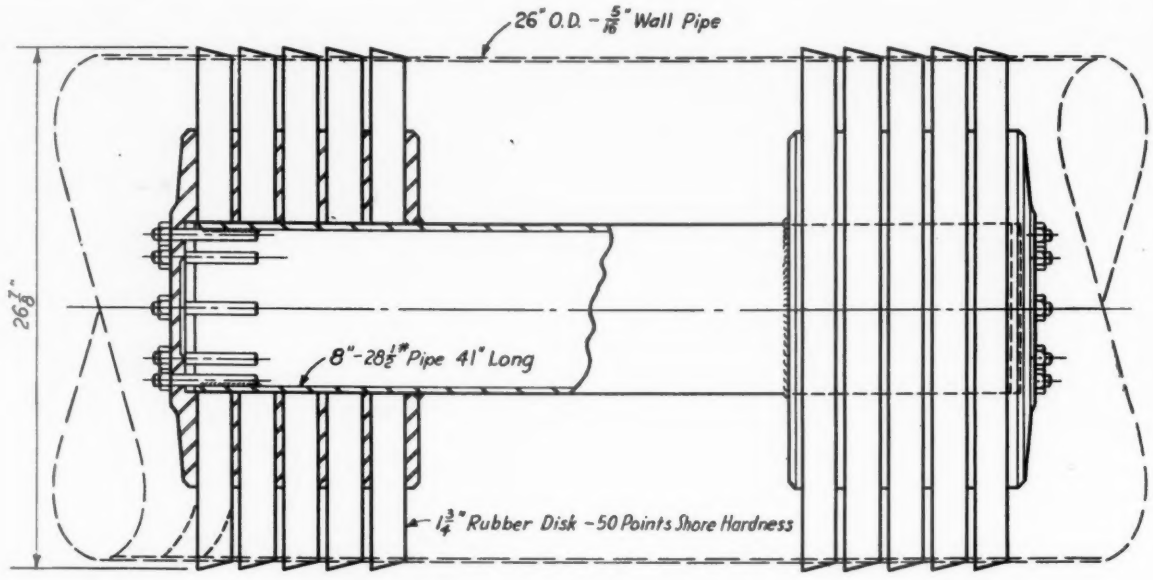

FIG. 4. Stanpac scraper, 26-in. rubber disk type.

100 yd long, in front of them. Wax was extruded from the line through loosely made up Dresser type couplings for about 30 sec before the scrapers passed. The wax was black, free from dirt, about the consistency of fresh apple butter, and very sticky. It was considerably softer than the wax formerly noted near the southern end of the line, probably because it had not been subjected to the drying action of larger quantities of dry gas passing through the line.

When the scrapers passed Milepost 151.6, the length of the solid wax plug was estimated to have increased to about 200 yd. The gas pressure necessary to propel the scraper had increased from a few pounds per square inch at the start to about 25 psi when the scraper reached Milepost 151.6.

At the Los Medanos end a scraper outlet had been constructed with two pieces of 26-in. pipe, each about 20 ft long. The downstream end was elevated 5 or 6 ft to discharge the scrapers upward above the ground surface. As the wax ahead of the scrapers emerged the load decreased and the speed of the scrapers increased until they reached the outlet. At this point their momentum had increased to the point where the downstream 20-ft section of outlet pipe was blown off, landing 50 ft away.

Three subsequent scrapings of this 25-mile northern section removed approximately 12 bbl of wax. The Dressered spools of 26-in. pipe at valve locations were then removed from this portion of the line for an inspection, which showed that there was still present on the pipe walls a thin coating of polished wax, about 1/32-in. thick.

The Dressered spools in this section were then replaced and the newly developed rubber disk type scraper inserted at Tracy behind a 175-bbl load of gas oil. The scraper with the gas oil in front was then forced through the line at an average speed of 10 mph. The rubber disk scraper, returned to Tracy, was then started on the job of cleaning the line south from that point.

In all, the scraping operation took 15 days to complete, during which 1060 scraper miles were traversed. It was estimated that about 3000 bbl of wax was removed, principally from the northerly 80 miles of 26-in. pipe. Although this constituted removal of the major portion of the wax, scrubbers were installed in the outlets from the main line for use until the remaining wax disappeared.

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How fossil fish remains have been used in Pacific Coast stratigraphy

By **LORE ROSE DAVID,** Richfield Oil Corporation

MODERN geology in its physical and economic aspects requires more and more emphasis on utilizing the basic sciences. The geologic study of the earth and its biological phases makes greater use now of knowledge of zoology and botany than ever before. The knowledge of fossilized organisms is essential not only in making age determinations and correlations of geological units, but also for a very important phase of modern geology—paleo-ecology. Paleo-ecology is the determination of the environments of ancient sea basins. Most of the oil pools for instance we are utilizing today, and which are discovered buried deep under the surface of the earth, were laid down many millions of years ago on the bottom of a sea basin that existed at that period of time; however, these oil deposits came into existence only under certain conditions. It is an important phase of petroleum geology today to find out more about these facts.

EXCLUSIVE

Only in certain parts of the ocean, and more likely in parts bordering the lands, were conditions favorable for the formation of oil. Paleo-ecology tells us what were the climatic and bathymetric conditions of accumulation of deposits. That means, how hot or how cold it was, and from how deep under the surface of the ocean were the sediments gathered that form the sedimentary rocks of today. Paleo-ecology also tells us, whether, during accumulation of a deposit, the sea was transgressing over the land, or whether it was a period of regression of the sea, and the land once covered by sea water rising above the level of the sea. This modern science also gives information concerning the position of the shore line of a former sea basin, a factor of special importance, as oil may have been trapped in the area of the shoreline against terrestial deposits of greater density.

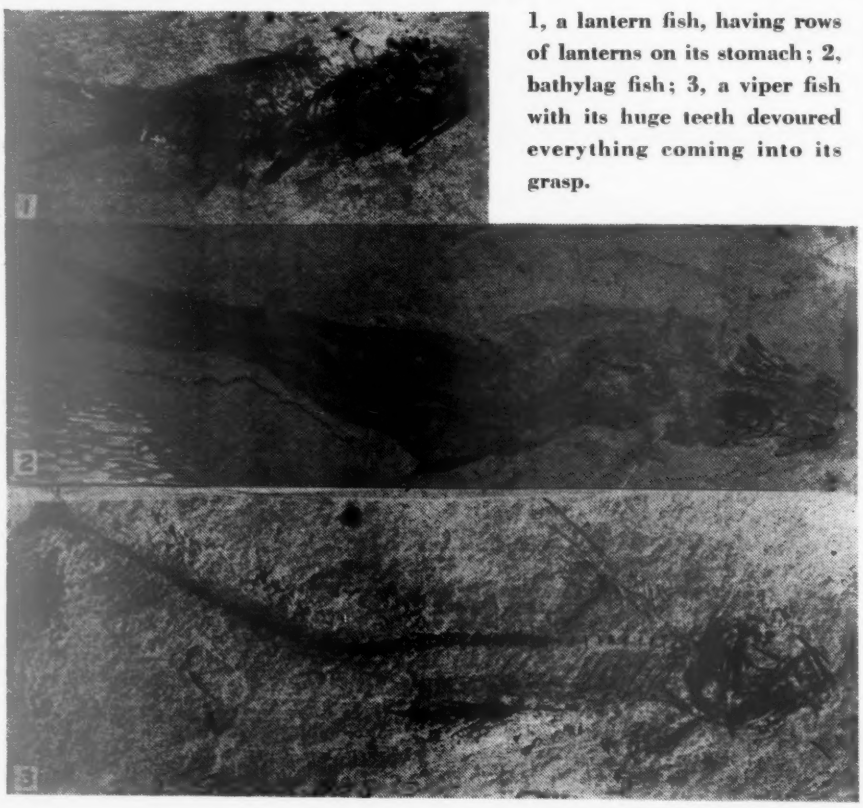
The Author

Lore Rose David came to the United States in 1937 and became a naturalized citizen in 1943. She has studied zoology and ichthyology at University of Leipzig and Munich in Germany, Sorbonne in Paris and British Museum in London, and holds a Doctorate of Philosophy from the University of Berlin in 1931 with a zoology major. Her thesis on mechanics of development, transplantation of extremities of black and white axolotls, was completed at Kaiser Wilhelm Institute for Biology.

In Europe Doctor David did research work in museums in London, England, in Leipzig and Frankfort, Germany, and in Tervueren, Belgium, from 1934 to 1937.

Since she has been in the United States she has worked with the Los Angeles Museum of Arts and Sciences, Scripp's Institution of Oceanography, and California Institute of Technology, Department of Vertebrate Paleontology, Pasadena. Since 1943 she has been paleontologist and paleoichthyologist for the Richfield Oil Corporation, Long Beach, California.

FIG. 1. These fishes came from fairly deep parts of the ocean, the so-called bathypelagic region of 100 to 1000 fathoms:



1, a lantern fish, having rows of lanterns on its stomach; 2, bathylag fish; 3, a viper fish with its huge teeth devoured everything coming into its grasp.

Among the fossils used for age determinations, foraminifera are by far the most important. Unknown some 30 years ago, their use is established now on a broad basis and petroleum geology could not well succeed in its exploration without the use of foraminiferal laboratories. No wonder that economic paleontologists keep on investigating other biological groups as new tools in stratigraphy and correlation.

Fish remains, especially single fish scales, are among the most abundant fossils of the Pacific Coast Tertiary, second

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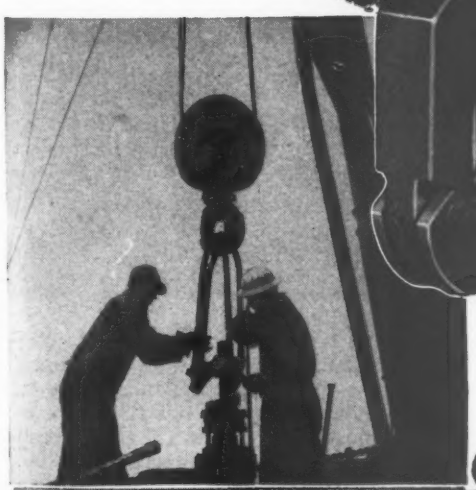

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Loads are carried in perfect balance. Hook may either swivel freely or be locked in any of eight positions by new swivel lock design. Flexing and fatiguing of hook under repeated heavy loads is avoided as hook link carries proportional part of load. Hook link is securely locked when closed, preventing possibility of elevator links or swivel bail "jumping out" should string momentarily hang up.

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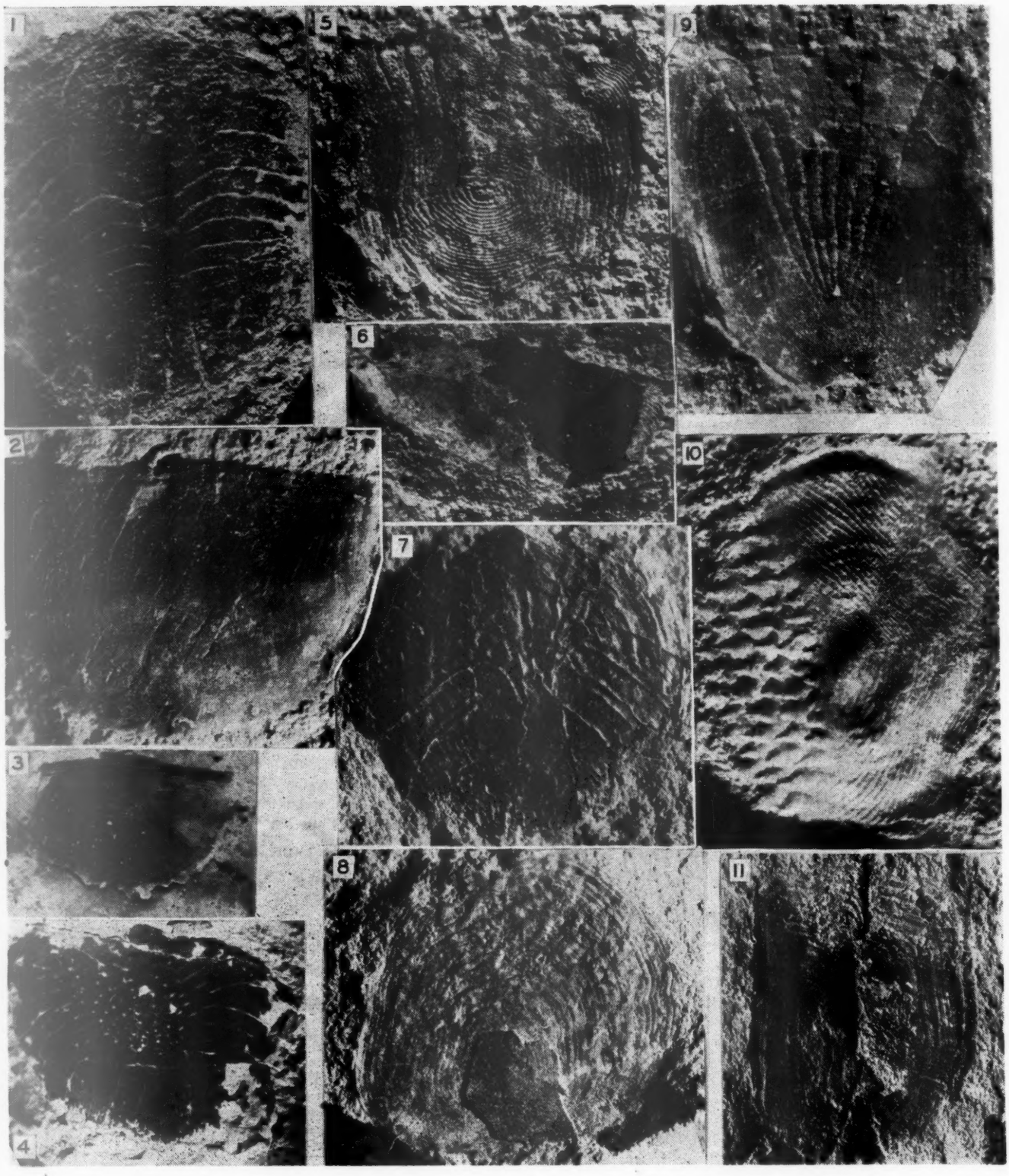
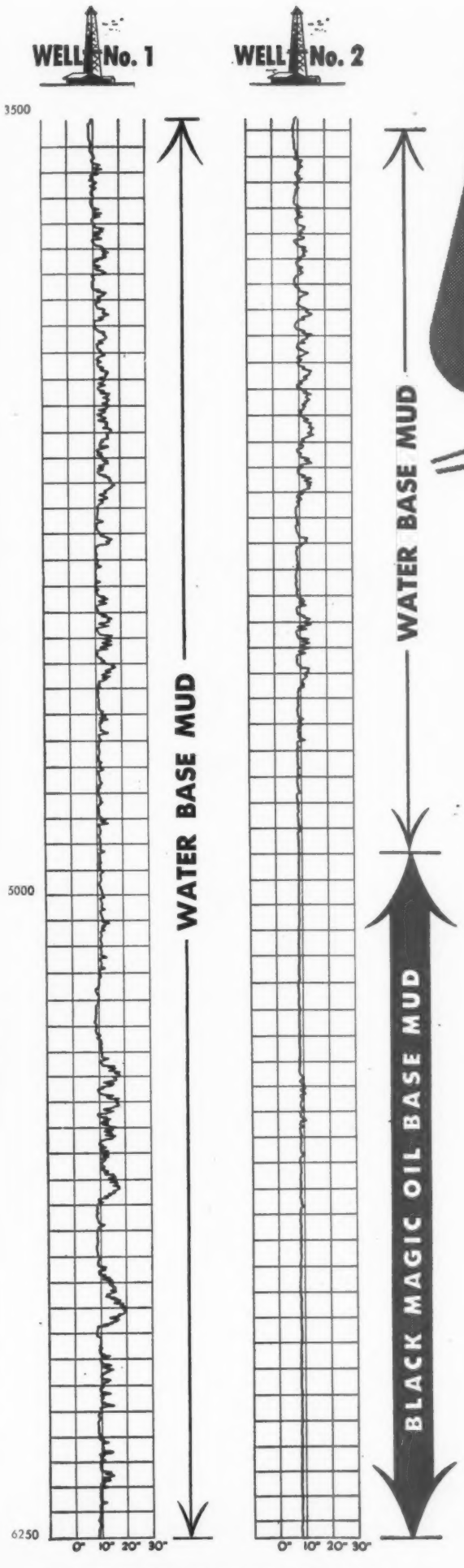


FIG. 2. Some of the many Upper Miocene markers; 1, the Upper Miocene round herring; 2, a smelt, related to the jack smelt; 3, a smelt-like fish, related to the grunion; 4, a shad, not related to any living species. Middle Miocene markers, these scales came from fish that liked a warm, shallow coastal sea, conditions that did not exist after the Middle Miocene in this area. 5, an extinct minnow, not related to any living form; 6, the scalloped upper border characterizes this smelt scale, only certain members of this family that live in warm water have such scales; 7, Middle Miocene round herring; 8, a salmon-like fish related to the Inconnu. Lower Miocene to Oligocene markers, all these fishes seemed to have lived in tropical water; 9, a grouper; 10, an alfonsino; 11, a lake herring.

to foraminifera. This is not astonishing because marine deposits play such an important role in the Pacific Coast geology of northern America. The study of fish scales was taken up only some five or ten years ago. This period was sufficient to show that scales and scale assemblages have significant differences in strata of different age. We know now that they can be used with confidence in stratigraphic problems of the Pacific Coast Tertiary. A great number of fish scales can be used characteristically as index or marker



Caliper log proves BLACK MAGIC keeps a hole "to gauge" and eliminates drilling hazards

HOW BLACK MAGIC oil base drilling mud keeps a hole "to gauge" is best illustrated in these actual caliper logs of two comparable wells drilled in the same Texas field. Well No. 1 was drilled with a water base mud. Note the irregular wall penetrations that are frequent causes for stuck pipe, that greatly increase cementing costs and sometimes cause casings and liners to collapse. Compare the close correlation between the two wells.

Well No. 2 was drilled partially with a water base mud and completed with Black Magic. Maximum hole deviation was 1½" in one short section, as against 12" for water base mud causing noticeable drilling hazards. In addition to keeping the borehole to gauge Black Magic did not water block or mud off production areas.

LONGER BIT TIME ON THE BOTTOM WITH BLACK MAGIC

By lubricating bit bearings and cutting down heat generation, Black Magic allows a longer bit time on the bottom. Greater total core recovery is assured and accurate information for development evaluation is obtainable with Black Magic as with no other medium. Water blocking and mudding off that restricts production is impossible when Black Magic is used. Black Magic can be regenerated for use over and over again, thus the actual cost is only for the amount of mud that is expended on each well, which averages about 5 to 10%.

BLACK MAGIC ELIMINATES CAUSES FOR "STUCK PIPE."

Pipe sticks for several reasons. These are the most common: 1. Shales that swell when water wet. 2. Large washouts that cave the walls of the hole. 3. Thick mud caking causing a hole to be "under gauge." 4. Mud with insufficient gel strength that allows cuttings and weight material to settle. 5. Formation contamination that adversely affects water base muds when drilling through salt domes, anhydrite, cement, gypsum and other mud contaminating materials.

A quick check reveals that all of these causes for stuck pipe are directly attributable to *water* in the drilling fluid. Black Magic has no water for shale to absorb (1); prevents washouts by keeping the hole to gauge (2); forms only a paper thin mud cake (3); a zero fluid loss makes control of the viscosity for proper gel strength a simple process (4); is unaffected by salt, cement, anhydrite, gypsum, etc. (5); In short Black Magic eliminates all the major causes of stuck pipe and has been used with success on over a thousand wells. *Write for "Oil Base Drilling Fluids"—paper delivered at 75th Annual meeting of A.I.M.E., giving production figures and detailed discussion.*

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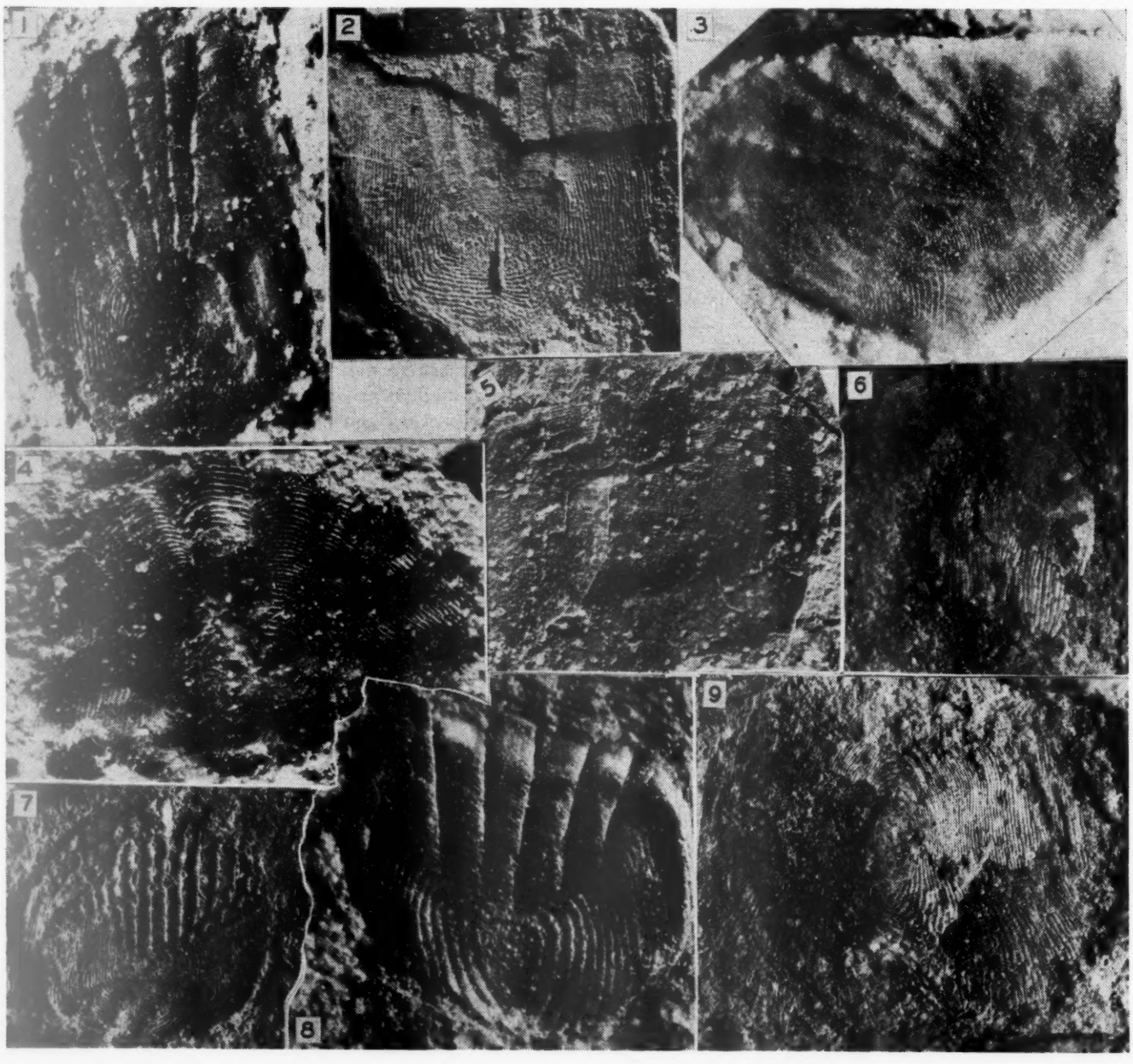
fossils. Others occur in well marked abundance zones, indicating in that way horizons of definite age, and making it possible to correlate quite accurately.

Fish scales are of even greater importance in paleo-ecology. As fishes are by far the most highly developed and specialized inhabitants of the oceans that occur in great variety and abundance, they are apt to give the most definite information on ecology and type of habitat in which a deposit was formed. Fishes are widely distributed throughout the oceans and occur in almost every portion of the seas from the greatest depth to shallow bays and from arctic regions to the tropics. Most fishes are specialized to typical environments. All this is not true for the majority of other animals that populate the ocean; most groups of organisms are quite restricted in their occurrence to certain types of environments or to certain regions. No group is as specialized and adapted to definite habitats as fishes are.

The reason why fossil scales have not been used before is that very little is known of the characteristic of scales of living fish and hardly any literature exists on the subject. In order to use fossil scales it is necessary to collect, study and classify scales of living fish first, then compare both.

Scales of different kinds of fishes show innumerable variations of their ornamentations, of the designs and angles formed by the fingerprint-like impressions that mark the scales. Looking at some pairs of comparable fossil and recent scales, we find that the mackerels, for instance, show wide almost horizontal lines, finer on the so-called apical pole that is the part of the scale that protrudes in the shingle-like pattern in which the scales are arranged on the body; croakers and basses like most of the higher or spiny fishes show radiating folds in their basal parts, which are attached to the body of the fish; there are numerous spiny protrusions on the apical edge. Flying fish-like forms have horizontal lines somewhat like the mackerel, but

FIG. 3. These scales came from shallow water fish: 1, a grouper scale from the Lower Miocene age; 2, a minnow scale of the Pliocene age; 3, a porgy fish scale, the right upper corner of the scale is not preserved, of the Upper Miocene age. These scales came from medium deep water in the oceans; 4, a lantern fish; 5, an alfonsino; 6, a bregmacerod codfish. These fish scales came from great oceanic depths of 1000 to 3000 fathoms; 7, a rat tail, called the herrings of the depths because they are so plentiful down there; 8, a heterom deep sea eel; 9, a deep sea cod. Note the distinct differences of fossil fish scales under microscope.



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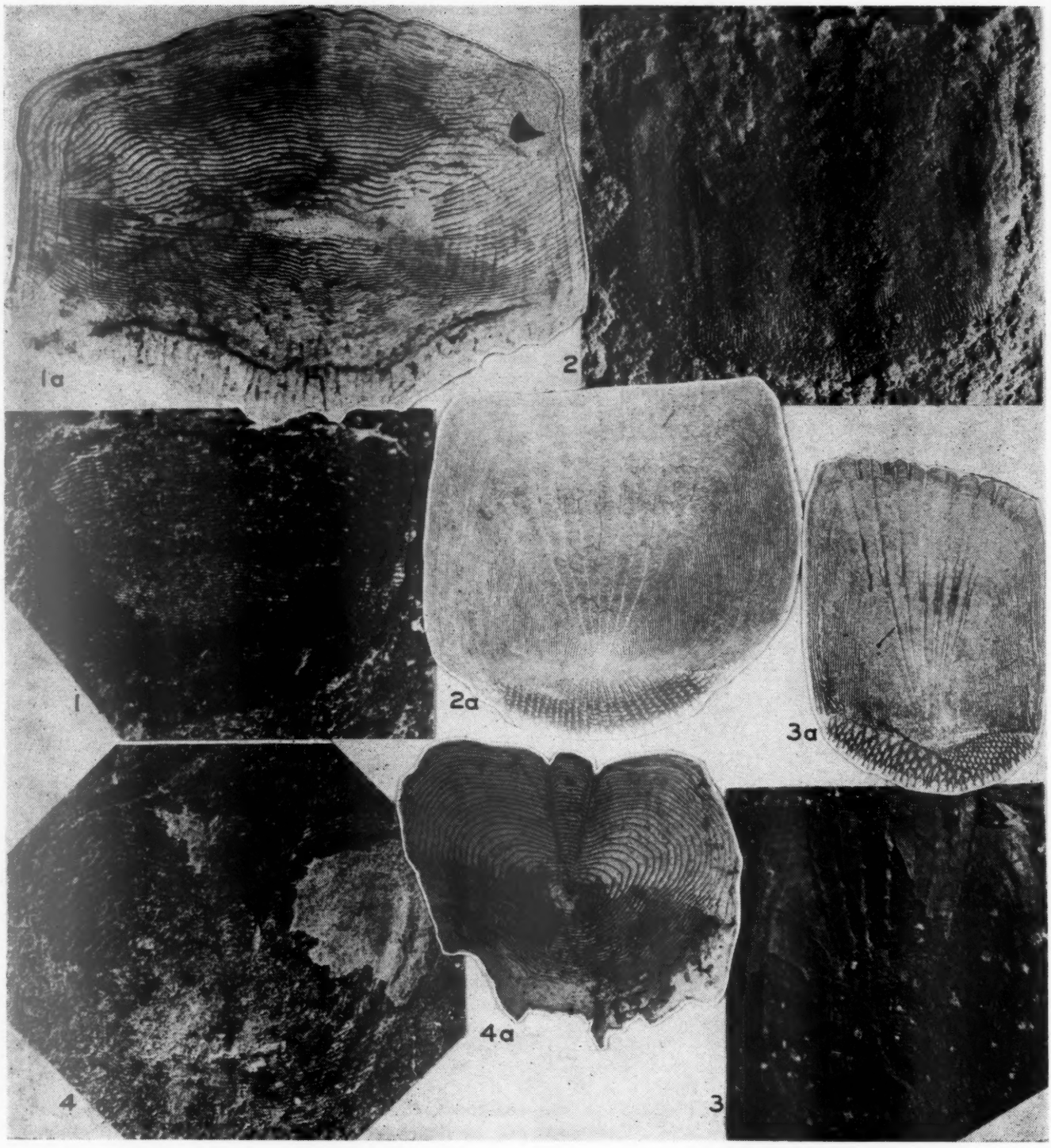

FIG. 4. Fish scales of recent fishes and their ancestors of many million years ago. 1 and 1a, mackerels—the fossil, 1a, is an Upper Miocene marker from coastal seas. 2 and 2a, croakers — the fossil, 2a, is of the same age and environment as 1a. 3 and 3a, basses—fossil is of Upper Eocene age and lives in coastal waters. 4 and 4a, flying fishes—the fossil is of Upper Eocene age and is an oceanic fish swimming far out from the shore.

Close inspection reveals similarity of scales of fossils and present-day fish.

much more rounded, and divided by deep protruding folds in the basal portion.

In order to use fossil scales in laboratory procedures a special method had to be worked out, which preserves the scales in a practical way, a method not too time consuming, and preserving sufficiently small specimens, that do not take too much space. Typical specimens of scales should be drilled out of the rock and placed on microslides. Of some of the smaller scales up to 30 can be placed on one slide. Small electric drills can be used or drills driven by compressed air, small diamond-coated or carborundum wheels are best for cutting through the hard shales. Only a small number of scales of each species need be preserved, the so-called "types." These serve to identify the species. For correlating from well to well charts can be drawn in each case that show the occurrences of the scales in each horizon just the same way as is being done for the foraminifera.

Enumerating some of the scales best usable in stratigraphy, we find many forms well known to those who like to angle for their food or at least to eat their fish on Fridays. We find that herrings and round herrings are the most abundant scales all through the Tertiary. This is not astonishing because herrings

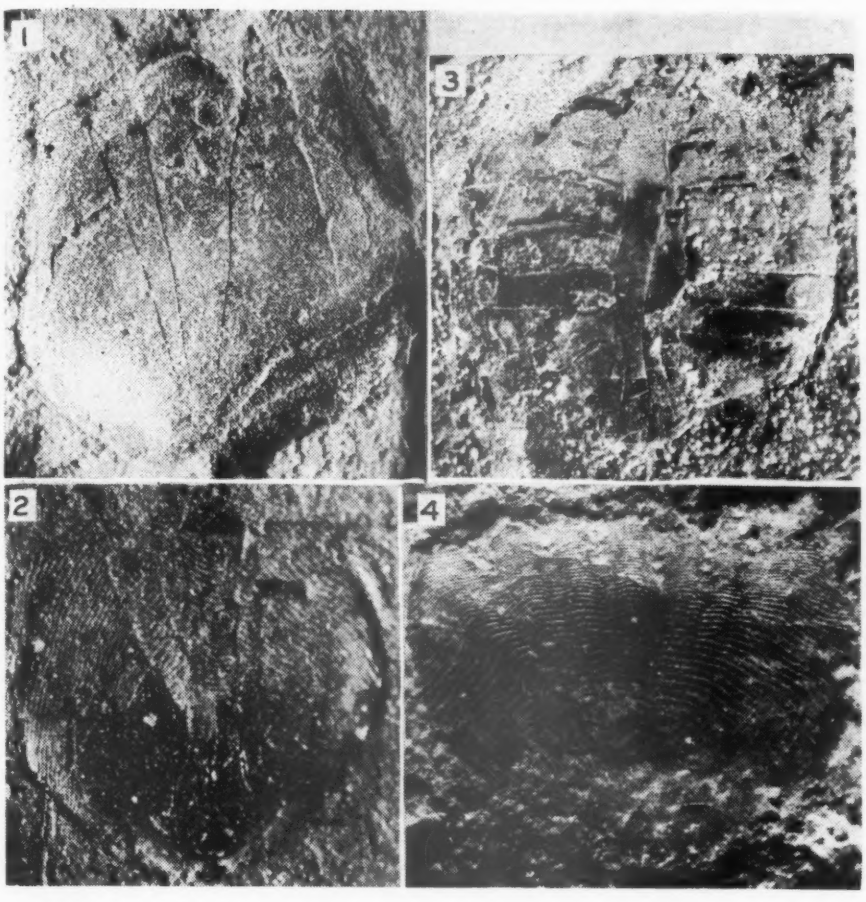

FIG. 5. Markers of the Upper Cretaceous age: 1, a lady fish; 2, a member of the Tarpon family. Markers of the Eocene age; 3, an Eocene roundherring; 4, a barbudo.

occur in great schools, evidently die in great numbers, and shed their scales easily. Among the herrings, the shad ranges from the Pliocene to the Middle to Lower Miocene, with at least four species existing, overlapping each other in their ranges. Three genera of round herrings exist with five or more species in strata of different ages. Three genera of true herrings exist with a number of species of each. There are also numerous smelts, some of them usable as markers. We might mention the alfonsinos and bermudos that form good markers for Lower Miocene, Oligocene, and Eocene. A number of salmons are well usable from Middle Miocene down to the Eocene. There are basses and croakers, flying fishes, mackerels and jacks and all the others!

A number of very distinct scales are of importance for paleo-ecological determinations. Quite a bit could be said about the way of living of the various fishes. The range of most of them is limited to a small region. Very few are of world wide distribution. The wide realm of the ocean can be divided not only into regions of different temperature, but also very definitely into different bathymetric regions, that is, areas of different depths.

Only fishes living in coastal waters are usually known to most people. We can distinguish fishes living in shallow lagoons or bays—very few of these are preserved in fossil deposits of the Pacific Coast, as porgies, or some of the groupers and occasionally minnows.

Most fishes populate the coastal waters toward regions of a certain depth and away from shore, the so-called neritic zone. It extends beyond the points of the sea where deep water fishing boats ordinarily go. Abundant neritic faunas are deposited in the fossil accumulations of the Pacific Coast, with fishes like herrings, smelts, basses, and rock cods, jacks and mackerels, flatfishes, flying fishes, croakers, and umbrinas — too many to be enumerated.

There are wide realms of the ocean beyond the neritic region, populated by fishes of very different structure and physiology. These are not generally known, for they cannot be fished for with ordinary fishing tools. The famous Professor Beebe has acquainted the public with some of the queer denizens of the deep sea, which he inspects and has photographed through his diving bell window. We can divide the depth of the ocean into two main bathymetric regions. The medium deep or bathyal zone and the abyssal zone. Ever so many of the queer deepwater fish are preserved in strata of the Pacific Coast.

In medium deep water deposits may be found whole little lantern fish with rows of phosphorescent (when alive) small lanterns along their tummies, and the scales of these fishes may often be seen on the surface of drill cores of Upper Miocene age in California. They are accompanied by other forms of medium depth like "Cyclothone," Viperfishes, "Bathylagus," exactly in the same percentual abundances as Professor Beebe has found them in the depth of the oceans that he has explored.

In really deep water, the abyssal, rat tails are abundant. They are often called the herrings of the depths, because they are as abundant down there as herring-like fishes are in coastal waters. Rattails are preserved in numerous kinds of species in many oil cores of the Pacific Coast, most often in the Oligocene. With them we find the scales of spiny deep sea eels, deep water cods, and many of the elongate teeth of the voracious fishes of the depth.

There is, indeed, a wide variety of petrified fish remains preserved in the sedimentary rocks of the Pacific Coast, and a careful study of the data presented yields a very graphic picture of fish life as it actually prevailed along our shores in prehistoric times. Doubtless, too, these fossil fishes are highly significant in the study of stratigraphy, sedimentation, and paleontology. Certainly progress so far made well justifies such a statement, and it seems quite rational to conclude that with continued interest in correlation by means of fish fossils, values already recognized may become more precise, and areas of application already known may be materially broadened.

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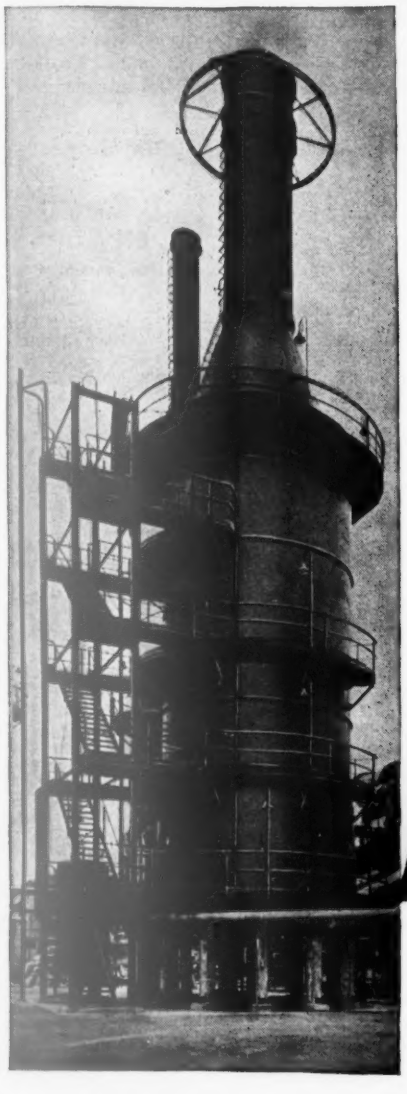

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Hypersorption-new fractionating process

By **CLYDE BERG** and **W. E. BRADLEY**
Union Oil Company of California

HYPERSORPTION is a name that has been coined for a new type of fractionation process developed by Union Oil Company of California. In essence, the process depends on the ability of activated carbon to adsorb selectively the less volatile constituents from a gaseous mixture while the more volatile constituents pass through the activated carbon bed essentially unaffected. The particularly novel feature of the Hypersorption process is the fact that a moving bed of activated carbon is employed to contact the feed gas and effect adsorption and fractionation of the desired constituents. The adsorbed materials are stripped from the carbon at an elevated temperature and, if desired, selective desorption can be employed to give two product streams from the stripping section. The stripped carbon, after passing through a cooling zone, is returned to the adsorption section for reuse.

EXCLUSIVE

Hypersorption is particularly applicable to the separation of light gaseous components without the use of extremely low temperatures or high pressures. It also is useful in the recovery of low concentrations of valuable components, the recovery of which by a more conventional means would be considered uneconomical. Some of the typical separations that can be accomplished readily by Hypersorption are as follows:

1. Separation of hydrogen from methane and heavier hydrocarbons.
2. Separation of ethane from natural gas.
3. Recovery of ethylene from cracked gas streams.
4. Recovery of CO_2 from flue gas.
5. Recovery of C_3 and C_4 hydrocarbons from lean gas streams.
6. Recovery of acetylene from gaseous mixtures.

The applications of Hypersorption extend far beyond those described above and it should be considered primarily as a new tool for the chemical engineer for his approach to the recovery and separation of relatively volatile compounds, particularly if present in low concentrations. As an example of an integrated plant employing Hypersorption, a flow sheet is presented in Fig. 1 for a unit to recover ethylene of high purity and with a high yield. The components of the feed gas and product streams are presented in Table 1.

TABLE 1. Hypersorption plant recovering ethylene from refinery gas streams with ethane cracking.

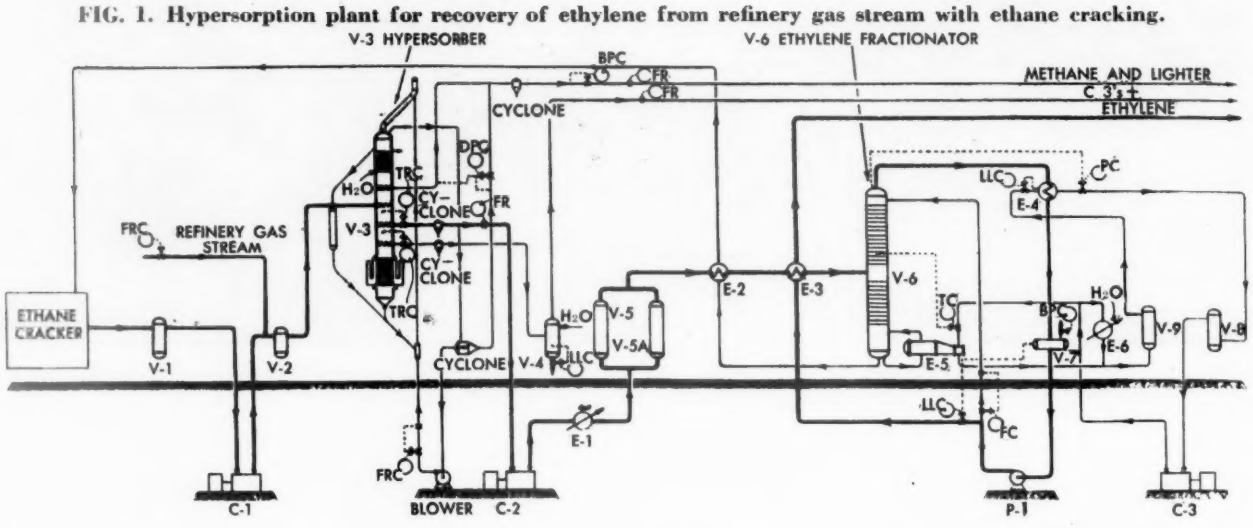
Component	Refinery gas	Hypersorber feed	Hypersorber discharge	Hypersorber make gas	Hypersorber sidecut	Ethylene fractionator overhead
H_2	2.23	11.91	25.40			
CH_4	51.55	35.46	73.92		2.70	6.45
C_2H_4	3.92	13.24	0.35	1.79	37.86	86.40
C_2H_6	22.58	25.18	0.33	3.44	58.34	7.15
C_3H_6	6.18	4.42		29.35	0.36	
C_3H_8	11.94	8.32		54.30	0.74	
C_4's+	1.60	1.47		11.12		

TABLE 2. Comparison of the capacities of activated carbon and absorption oil for retention of high hydrocarbons.

60 minute chloropicrin activity cocoanut shell—activated carbon
200 molecular weight absorption oil—temperature of adsorption 100 F

Hydrocarbon	Pressure, psia	Retention on activated carbon, lb/lb	Retention by absorption oil, lb/lb	Ratio of adsorption to absorption	Boiling point, F
Methane	1	0.00199	0.000022	90.5	—300
	10	0.0075	0.00022	34.0	—268
	25	0.0139	0.00055	25.2	—249
	40	0.022	0.00088	25.0	—237
Ethane	1	0.023	0.00027	85.0	—198
	10	0.065	0.0027	24.1	—140
	25	0.090	0.0068	13.2	—110
	40	0.122	0.0107	11.4	— 88
Propane	1	0.113	0.0014	80.7	—136
	10	0.172	0.0140	12.3	— 62
	25	0.186	0.0340	5.5	— 20
	40	0.200	0.055	3.6	— 2

FIG. 1. Hypersorption plant for recovery of ethylene from refinery gas stream with ethane cracking.



Important steps in the cycle of operation in this plant are as follows:

(a) Recovery of ethylene and heavier components from a refinery gas stream and ethane cracker effluent in the Hypersorption unit to produce three product streams consisting essentially of C_1's, C_2's and C_3's, respectively.

(b) Separation of ethylene and ethane in a small low-temperature column to provide the recycle stream for ethane cracking.

(c) The C_3 fraction is produced directly for use as fuel or in other chemical processing operations. This fraction can be cracked for a maximum overall production of ethylene if desired.

It will be noted that in the above application the Hypersorption unit replaces the high pressure, low temperature demethanizer employed in conventional plants.

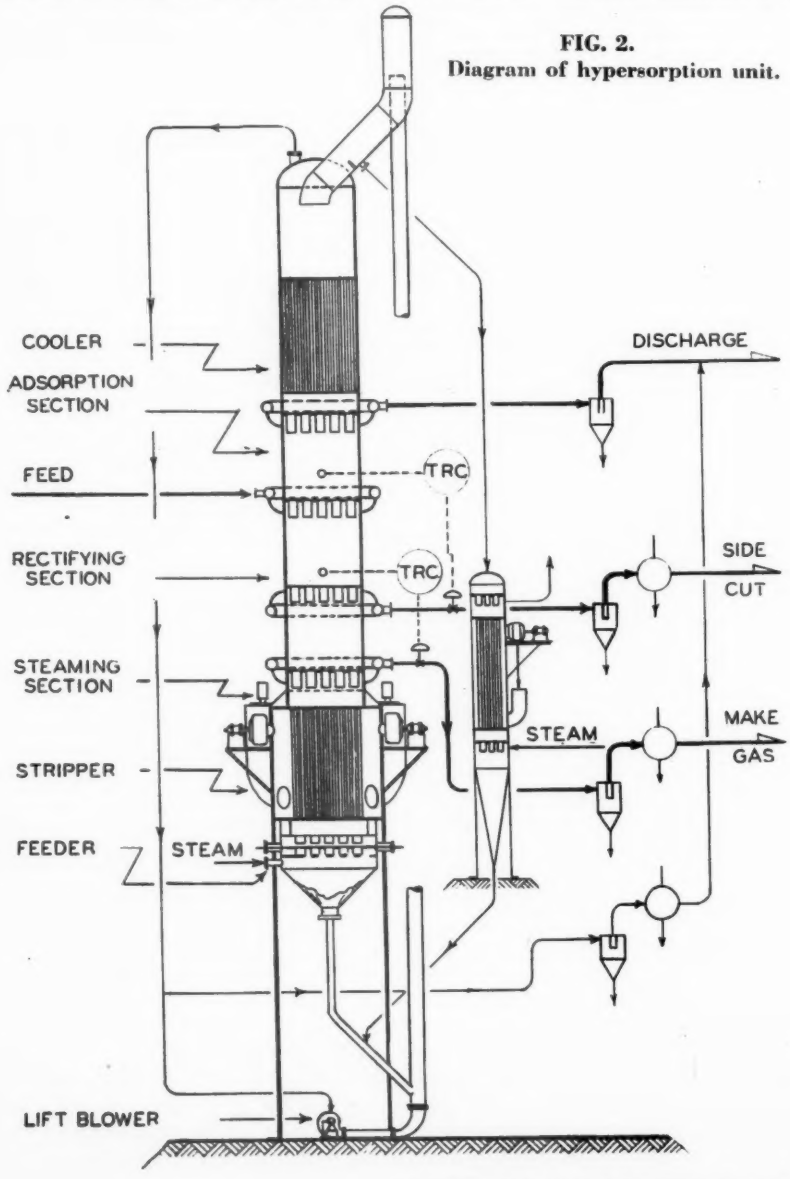
● **Process details of Hypersorption unit.** The Hypersorption unit comprises two major heat transfer sections, consisting of vertical tube in shell exchangers, separated by adsorption and rectifying sections with internals for introduction and take-off of the various gas streams. These components are assembled to form one vertical cylindrical column with a cooler at the top and stripper at the bottom. A gas lift system is incorporated for circulating solids from the bottom of the unit to the top. This construction is illustrated in Fig. 2.

The unit is filled with a bed of granular activated carbon, the upper level of which is maintained in a hopper at the top of the unit. This continuous bed slowly moves downward and the circulation is controlled by the rate of release of the activated carbon from the base of the column into the lift system used to return the activated carbon to the hopper at the top of the unit.

The activated carbon passes downward from the hopper through vertical tubes where it is cooled prior to entrance to the adsorbing sections below. A gas stream simultaneously flows countercurrent to the carbon passing through the cooler and serves to remove effectively any water vapor retained on the carbon from the stripping operation.

The feed gas is introduced through a distribution plate near the center of the adsorption section and passes upward countercurrent to the moving bed of activated carbon. The unadsorbed lighter components are discharged at the top of the adsorption section just below the cooler. The activated carbon below the feed point, which contains the adsorbed heavier components, passes downward to the rectifying section where it contacts a reflux of heavy constituents liberated by the stripper at the bottom of the unit. This reflux serves to liberate any lighter constituents that may contaminate the adsorbed material. A con-

FIG. 2.
Diagram of hypersorption unit.



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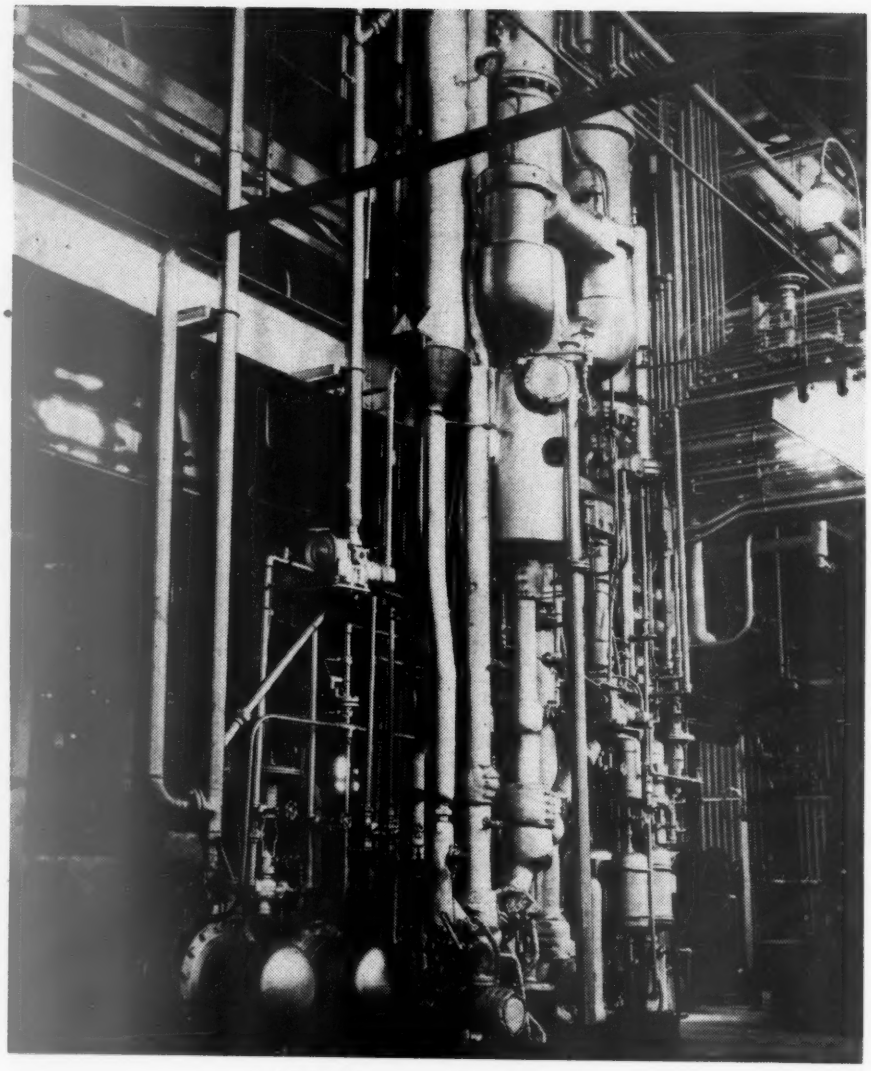
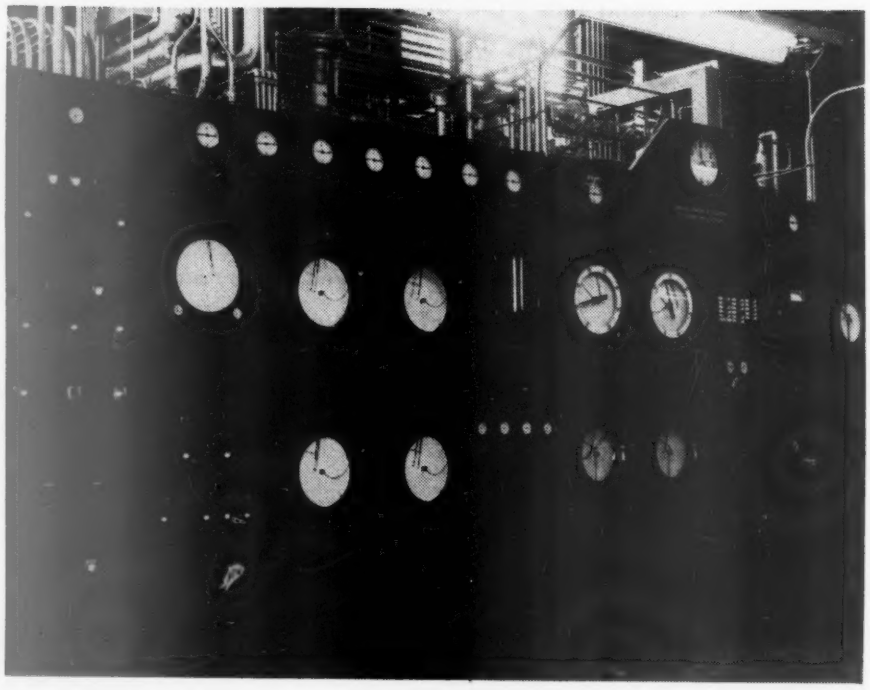


FIG. 3. Hypersorption pilot plant.

FIG. 4. Hypersorption pilot plant control board.



centration of intermediate constituents in the vapor phase develops in this section, and, if desired, a disengaging tray may be placed at this point and intermediate constituents produced as a sidecut.

The activated carbon flows downward through a lower disengaging section and into a short steaming section directly above the stripper proper. There it meets an upward flow of steam liberating the adsorbed heavier components, which are either produced as bottom product gas or returned to the rectifying section above as reflux.

Steam introduced below the stripper passes countercurrent to the activated carbon in the vertical stripper tubes, through the steaming section, and is discharged with the bottom product gas.

The increase in temperature of the carbon throughout the steaming and stripping section is gradual, the highest temperature being attained at the base of the stripper. Most of the adsorbed materials are removed before the carbon passes through the stripper proper. The flow of activated carbon leaving the base of the unit is controlled by means of a specially designed feed mechanism that gives positive control of the flow distribution in the cross-section of the unit. The activated carbon drops from this mechanism into a sealing leg that restricts flow of steam into the lift system. The activated carbon is transported to the top of the Hypersorber tower by an elevator or gas lift and drops into the hopper situated at the top of the unit.

For the purpose of maintaining a high level of activity, a reactivation unit is provided that circulates a small stream of carbon in parallel with the Hypersorber and carries out a high temperature, steam-stripping operation to remove any accumulation of heavy residual hydrocarbons on the adsorbent.

The adsorption of gas on activated carbon is exothermic and, since heavier components are more readily adsorbed than the lighter constituents, the temperature of the activated carbon bed is characteristic of the composition of the materials being adsorbed at any given point. Control of separation in the Hypersorption unit utilizes this principle.

The sidecut and bottom make gas streams are governed by automatic temperature controllers that operate on the rather substantial temperature breaks corresponding to the separation points between the various classes of components being treated.

The carbon circulation in these units varies widely depending on the type of feed gas processed and the pressure of operation. It is always a fraction of the weight of absorption oil that would be required for an equivalent recovery as indicated in Table 2.

Stripping steam rates are quite low being on the order of 10 to 15 lb per 1000 lb of carbon circulated. The superficial vapor velocities employed are one-half to one-third those employed in conventional fractionating towers.

In Figs. 3 and 4 are presented photographs of a Hypersorption pilot plant.

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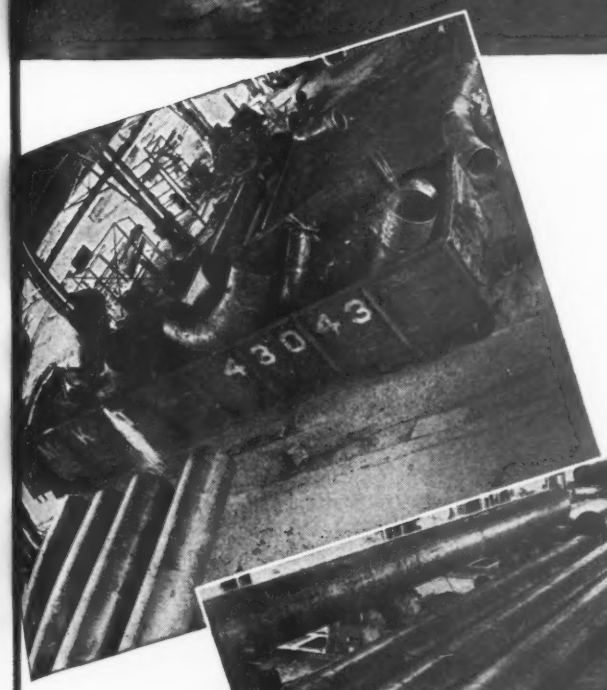

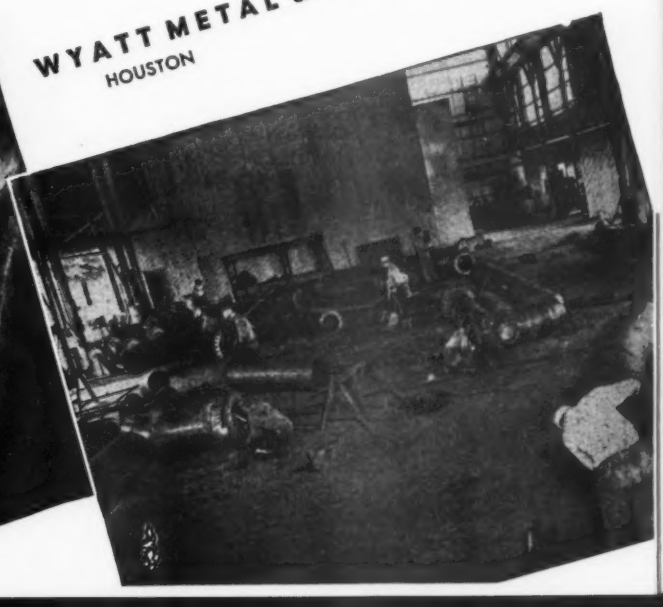

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Low pressure oxygen process

By **WALTER E. LOBO,** The M. W. Kellogg Company

EXCLUSIVE

CONSIDERABLE interest has been aroused in recent months over the prospect of employing oxygen for industrial processes that now utilize air as the oxidation medium. Prominent attention has been given to the use of oxygen or enriched air in the synthesis of gasoline and oxygenated chemicals from natural gas; in the blast furnace and open hearth furnace for the manufacture of pig iron and steel; in the manufacture of producer gas and water gas, and in a number of chemical oxidation processes such as the manufacture of nitric acid from nitrogen, the manufacture of sulphuric acid by the Contact Process, and others.

This interest has arisen because of the development during the war of a highly efficient technique for manufacturing large quantities of oxygen at low cost. The cost of oxygen has indeed been the major objection to its use by the metallurgical and chemical processing industries, who long have recognized its advantages in increasing capacity, reducing fuel consumption, and reducing labor, costs and fixed charges per unit of output. The phenomenal success obtained in reduction of cost of oxygen has been due largely to an organized development program in which universities and commercial firms participated.

A major use for tonnage oxygen in the immediate future may lie in its application to the so-called Fischer-Tropsch gas syntheses in general and, more particularly, to the conversion of natural gas to liquid fuels and useful organic chemicals. As the use of oxygen is contemplated for the production of synthesis gas for such reactions, its cost of manufacture becomes a prime consideration in making the process economically competitive with refining methods as practiced today.

Fortunately, considerable research and development during and since the war has brought the price of process oxygen down to an exceedingly low level —figures on the order of $3.50 a ton being feasible when manufactured in large quantities. In addition, when an oxygen plant is operated in conjunction with a synthesis plant, the large amount of waste heat released by the combustion of methane and by the exothermic catalytic reaction of CO with H_2, can expediently be used to supply steam power for the oxygen plant and thus reduce the cost of oxygen still more.

● **Organization for oxygen research.** The facts on the development of the low pressure oxygen technique and the salient features of the new process provide a striking narrative of modern industrial efficiency, which is vital to the thinking of all refining personnel.

THE AUTHOR

Walter E. Lobo is well known in engineering circles as a lecturer on scientific subjects and author of numerous papers on furnace design, heat transfer, and pressure drop. As director of the Chemical Engineering Department of M. W. Kellogg, he is in charge of all non-petroleum process design.

During the war Lobo served as consultant to the Oxygen Division of the NDRC and coordinated the engineering efforts, which led to today's improved processing methods. He is a former committee chairman on direct fired heaters and boilers for American Society of Mechanical Engineers, and a member of Publication Board of the American Institute of Chemical Engineers.

About one month after Pearl Harbor, The M. W. Kellogg Company was called upon by the National Defense Research Committee (NDRC) of the Office of Scientific Research and Development (OSRD) to act as the central engineering organization for the development, design, and testing of oxygen plants to meet the war needs of the armed services. Compact, lightweight, mobile, sturdy plants were required by both the Army and Navy to provide oxygen at advanced bases for welding and cutting of metal, for medical purposes, for high altitude flying, for air conditioning of submarines, and for underwater propulsion engines. Kellogg was directly responsible for the design and engineering of these units and was instrumental in obtaining the aid of other companies for the development of necessary items of mechanical equipment.

After study of the many possible ways to produce oxygen, the low temperature air fractionation process was chosen as the best for the accomplishment of these aims. For the development of the process, two distinct fields were outlined by Kellogg. The first had to do with process information such as thermodynamic data, low-temperature insulation, heat exchangers, fractionation, packed column efficiencies, etc. The second concerned mechanical items—lightweight engines, air and oxygen compressors, and low temperature expansion engines.

Out of this study came the M-7 unit,[1] the first successful low-pressure, mobile gaseous oxygen producer. This unit operated at air pressures of 100 psi in favorable contrast to the very much higher pressures of older processes.

● **Oxygen separation complicated by air impurities.** On the surface, oxygen manufacture appears exceedingly simple. All that is required is to compress air, convert it to a liquid by allowing it to expand through an orifice, and then distill the resulting liquid air to separate the oxygen (21 per cent) from the nitrogen (78 per cent).

Unfortunately, air is not simply a mixture of oxygen and nitrogen but also contains small amounts of water vapor, carbon dioxide, hydrocarbon, and "rare" gases. Air to be liquefied must first be purified of water and CO_2 to prevent their solidification in the equipment and eventual blocking of the flow of gases.

● **Linde process.** The history of oxygen production might almost be written upon the basis of how the baffling problem of economic removal of these impurities has been solved. In the first oxygen plants, employing the so-called Linde Process, air was compressed to the high pressure of 3000 psi and the impurities removed chemically.

● **Linde-Fränkl Process.** About 1930, a German, Matthias Fränkl, employed a "regenerator" or cold accumulator for the double purpose of freezing out the impurities from the air stream and cooling the incoming air. The modified process came to be known as the Linde-Fränkl Process and was undoubtedly the most advanced technique in oxygen production at the outbreak of World War II.

Its distinguishing feature was that the cold oxygen and nitrogen streams from the fractionation of liquid air were passed through a pair of "regenerators" packed with crimped aluminum of high heat capacity, until the metal temperature was approximately that of the gas streams. Then the oxygen and nitrogen streams were switched to another pair of regenerators and the fresh feed air was switched through the first pair, which were now so cold that the water and carbon dioxide in the entering air were precipitated out in passing through them. This innovation did not require the usual tubular heat exchangers and allowed the majority (96 per cent) of the fresh feed air to be purified of water and carbon dioxide without the use of chemicals, the rest of the air being purified at high pressure by chemical means.

The Linde-Fränkl Process succeeded in markedly reducing the cost of oxygen, but suffered from the inherent disadvantage of contaminating the pure oxygen stream, used to cool the regenerator, with residual air left in the regenerator at the end of a heating cycle. Nevertheless, al-

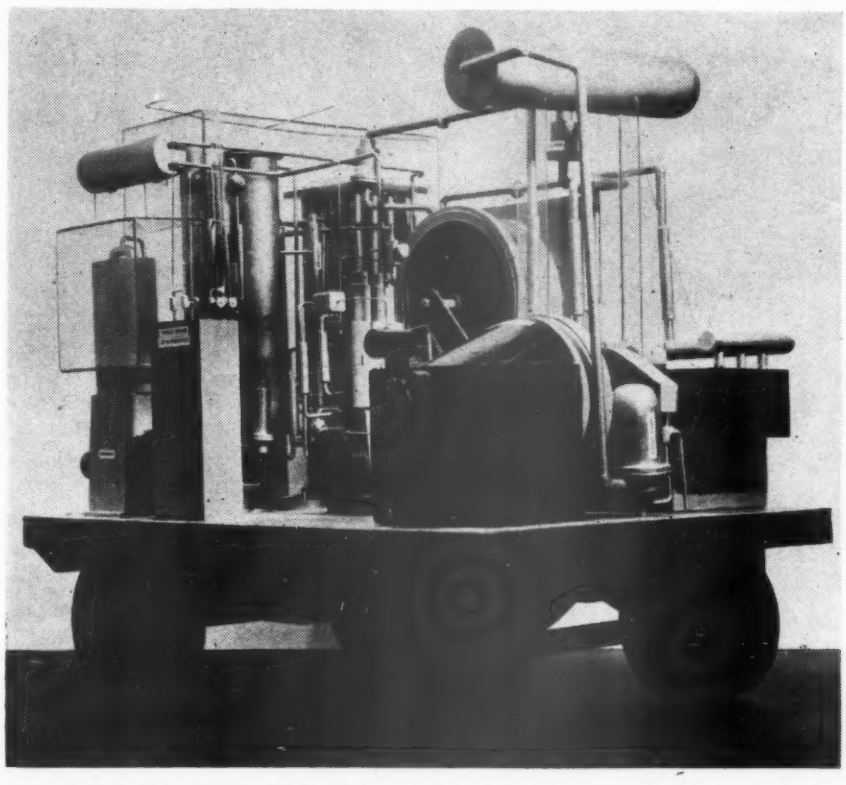
though high purity oxygen could not be produced, the Linde-Fränkl Process was widely adopted by oxygen manufacturers in Germany and Europe.

● **Reversing exchanger.** The next development occurred in this country during the war and resulted in better, simpler, cheaper plants, which could be built in any size to produce high or low purity oxygen as desired. The distinguishing features of these modern oxygen plants are first, the multipass reversing heat exchanger, which completely purifies low pressure (90 psig) air by physical means, and second, elimination of any high pressure air processing, thus reducing initial cost.

In principle, the reversing heat exchanger consisted of three coaxial tubes —one each for air, nitrogen, and oxygen. Extremely cold pure oxygen and waste nitrogen from the fractionator cooled the fresh feed air by heat exchange, and at the same time froze out the carbon dioxide and water similarly to the action in the Linde-Fränkl regenerator. The two ingenious modifications, however, were that first, all the oxygen product passed continuously through a central passage in this exchanger, and thus as it never came in contact with any impurities, it could be produced in concentrations of 99.8 per cent if desired; and second, every few minutes (three was the usual number) an automatic cycle timer reversed the channels in which the nitrogen and feed air flowed. Low pressure nitrogen thereupon flowed in the impurity-laden channel formerly traversed by air, scavenged the channel by re-evaporation of the impurities, and exhausted them to the atmosphere. At the same time, air flowed in the cold and clean channel formerly traversed by nitrogen. This automatic switching avoided plugging channels with ice and solid CO_2.

● **Temperature unbalance.** Unfortunately the original exchanger developed could run only about 24 hours before becoming plugged with impurities. It was soon established thermodynamically[2,3] that, for long-term operation of reversing exchangers, the nitrogen at each point in the exchanger *could be no more than a few degrees colder than the fresh feed air in heat exchange with it.* Only if this relationship existed could the impurities deposited in the exchanger channels from the fresh air be completely evaporated into the nitrogen stream on flow reversal. Yet the nature of the process was such that no matter how the variables were adjusted, the equilibrium temperature difference between the entering nitrogen and the exit air at the cold end of the reversing exchanger was at least 25 F. With continued operation of the exchanger under these conditions, a gradual build-up of impurities in the passages occurred, even though the nitrogen was at a much lower pressure than the air. To solve this problem, P. R. Trumpler of Kellogg conceived and worked out a unique "temperature unbalance" system[4] whereby the 25 F differential between nitrogen and air could be reduced to the permissible maximum —a range that permitted complete purification and truly continuous operation of the reversing exchanger.

Model of the M-7 Oxygen Plant for producing one ton of 99.5% pure oxygen per day. This was the prototype of the mobile oxygen unit developed for U. S. Army and was Kellogg designed and engineered. It weighed 8 tons including trailer. Trailer dimensions were 12 ft by 8 ft by 8 ft.



The Trumpler contribution was the addition of a fourth non-reversing passage to the exchanger. Via this channel, a portion of the fresh feed air that has been cooled to near liquefaction temperature in the exchanger is utilized at the cold end of the air passage of the exchanger *to supply additional cooling to the air stream* and thus lower the exit air temperature further toward the nitrogen temperature. In effect, the air stream is used twice for heat exchange—once with nitrogen and once (part of it) with itself. This "unbalanced" technique of artificially lowering the temperature at one end of the exchanger not only reduced the temperature differential from 25 F to, say, 8 F but the additional cooling imparted to the air stream improved the degree of purification.

In Kellogg units, control of the temperature difference is effected simply and automatically by controlling the unbalanced air return to the exchanger.

These units also employ an improved design of reversing exchanger that is more adaptable to commercial fabrication and operation than the annular type.

● **Expansion engines.** No less important than the reversing heat exchanger was the development of highly efficient low-temperature expansion engines for supplying the needed refrigeration. At the request of Kellogg two types were developed—one, a high speed turbine, and the other, machines of the floating piston reciprocating type. The larger machines of both types had efficiencies in excess of 80 per cent.

In Kellogg units, a single expansion turbine is employed for normal operation, and the external work it produces may be absorbed by an induction-type electric regenerator. This latter is connected to the plant power line for recovery of electrical energy produced.

● **Air compressors.** One of the principal economic advantages of today's Low Pressure Oxygen Process (90 psig) is that high speed rotary or centrifugal compressors can be utilized in place of reciprocating compressors. Of great practical importance, too, is the fact that such rotary compressors operate without oil or water lubrication in the parts in contact with the compressed air and thus eliminate a source of air contamination.

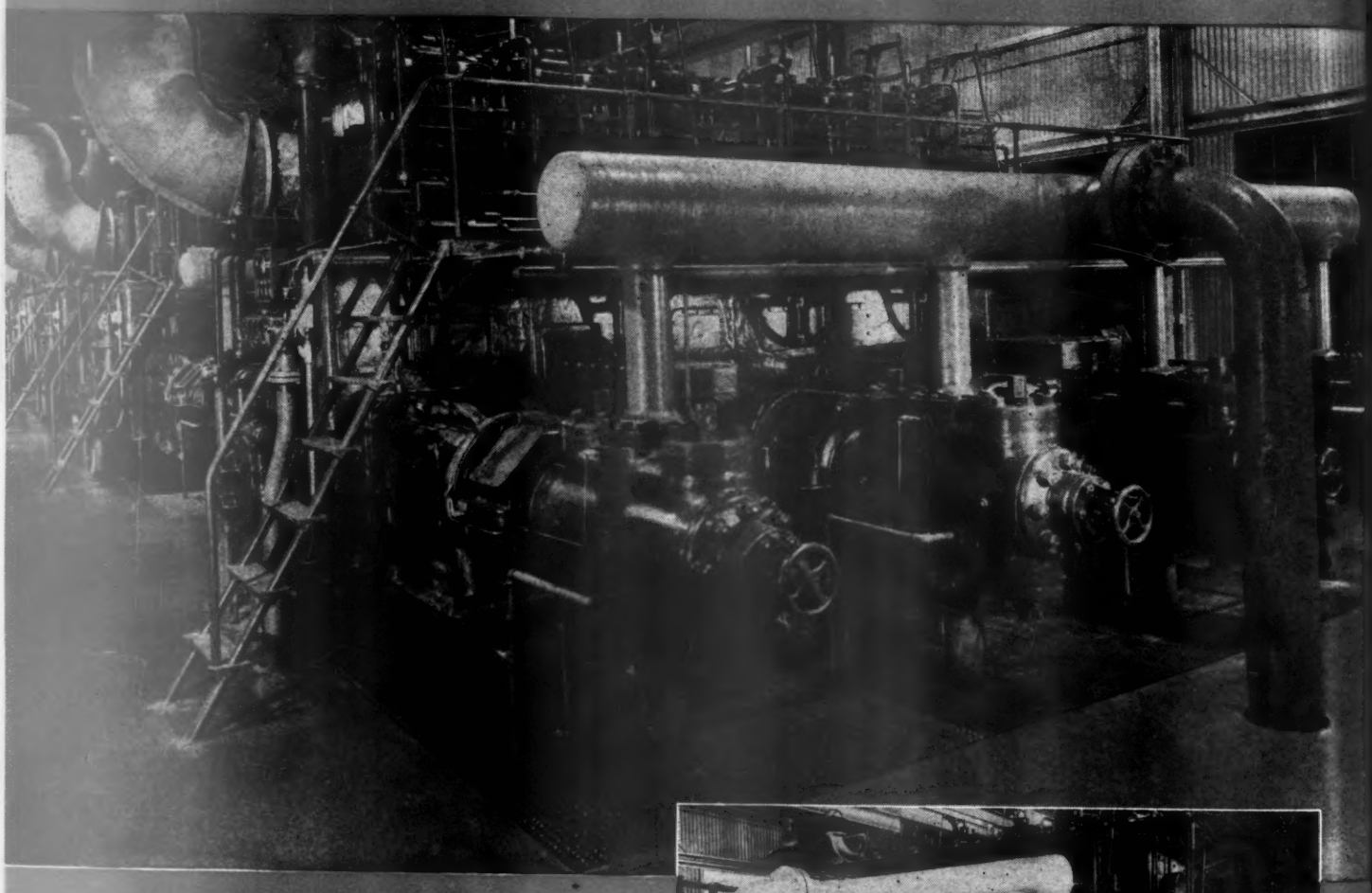
The units employ a two-stage, intercooled, turbine-driven centrifugal air compressor, which delivers clean air at 91.5 psig and 90 F to the air inlet of the reversing exchanger.

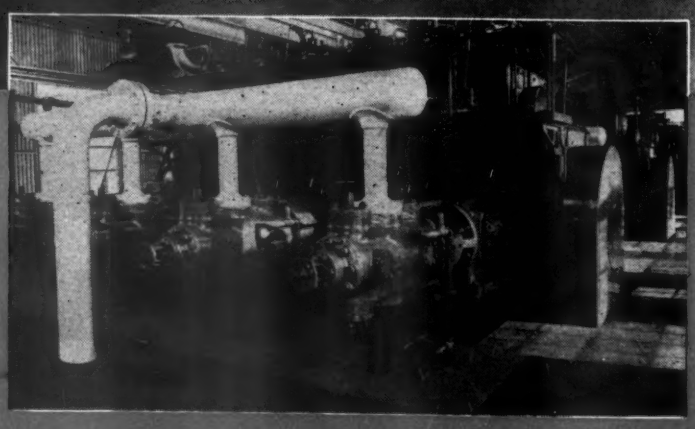
● **Safety.** There is always the element of safety to consider in the separation of oxygen by liquid air fractionation because of the presence of small traces of acetylene and other hydrocarbons in the air, or their introduction from oils used to lubricate the compressors. If no counter-measures are taken, these hydrocarbons may accumulate in the liquid oxygen bath at the base of the fractionating column and could cause a serious explosion. Provision is therefore made to remove completely all hydrocarbon impurities from the air before it enters the fractionating tower.

GAS PIPE LINES HAVE CHOSEN

400,000 BHP of Clark Compressors

IN LAST TEN YEARS



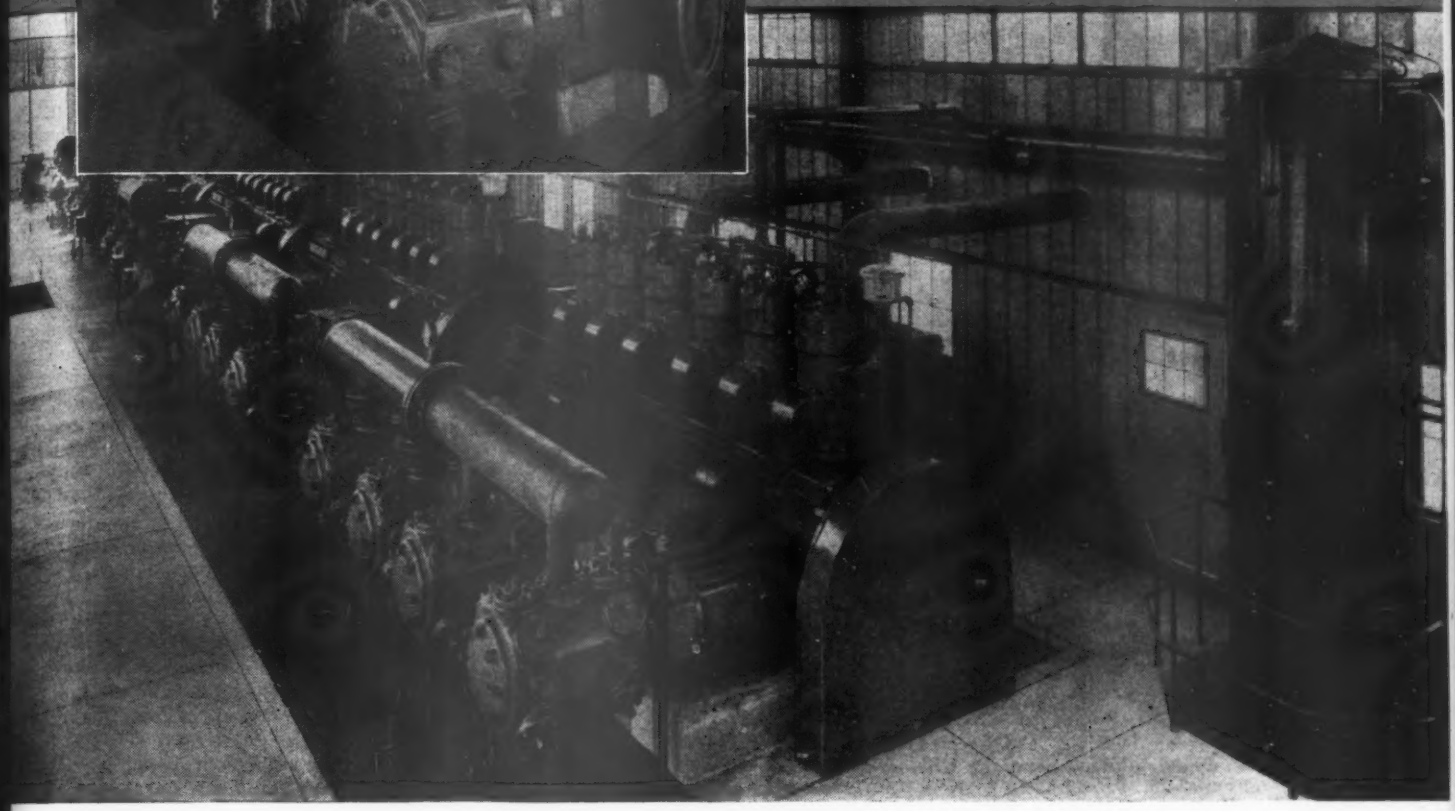


PROVED IN SERVICE

Two compressor stations on the Tennessee Gas & Transmission Co. pipe line, equipped with Clark "Big Angle" gas-engine-driven compressors. Each installation consists of nine 6-cyl. 1,200 BHP units.

LINE-TESTED

At left: At Jal, New Mexico, on El Paso Natural Gas Co. pipe line, 8 Clark 8-cyl. Right Angle Compressors, a total of 6,400 BHP. Below: East Ohio Gas Co. compressor station near Canton, Ohio. Installation consists of 7 Clark "Right Angles", 6 cyl., 600 BHP each.



The roll call of great pipe lines using Clark engine-compressors includes the following partial list of famous names:

Colorado Interstate Gas Co.
Consumers Power Co.
East Ohio Gas Co.
El Paso Natural Gas Co.
Hope Natural Gas Co.
Memphis Natural Gas Co.
New York State Natural Gas Co.
Panhandle Eastern Pipe Line Co.
Southern Union Gas Co.
Tennessee Gas & Transmission Co.

The proved performance of Clark units in this service is indicated by the impressive 10-year total of 400,000 BHP either in use or now in production, for gas pipe line stations exclusively.

More than one third of that total, or 145,200 BHP, consists of "Big Angle" Compressors, the first unit of which was placed in service 4½ years ago.

Rating 200 BHP per cylinder, the Clark "Big Angle" is the most powerful right angle gas-engine-driven compressor ever built. It is the answer to the need for *greater power in less space* and at *lower over-all cost.* Sizes: 5-cyl. 1,000 BHP; 6-cyl. 1,200 BHP; 8-cyl. 1,600 BHP; 10-cyl. 2,000 BHP.

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CLARK

ONE OF THE DRESSER INDUSTRIES

SETS THE PACE IN COMPRESSOR PROGRESS

● **Liquid air fractionation.** In fractionation of liquid air, The M. W. Kellogg Company was also able to apply its extensive knowledge of petroleum refining techniques toward improvement of the older process.

The separation into oxygen and nitrogen in modern plants is accomplished in two stages within a single fractionating tower—one stage at comparatively high pressure and the other at low pressure. First, a rough separation is made at 89 psi pressure into nitrogen and rich air (about 37 per cent oxygen). Then the rich air is fractionated at 9 psi pressure into oxygen of the desired purity, with liquid nitrogen from the first stage providing reflux for the second stage.

A combination condenser-reboiler section is employed in the fractionator between the two stages. In this way, nitrogen is condensed at the top of the high pressure section through heat exchange with boiling oxygen in the bottom of the low pressure section.

As the fractionating column must operate at —310 F, it is important that its volume be as small as possible, and that it be extremely well insulated to minimize heat leaking in from the outside. To satisfy this minimum space requirement, Kellogg developed a new type of high-efficiency, high-capacity perforated tray, which was tested for the NDRC at Pennsylvania State College and in the Low-Temperature Thermodynamics Laboratory set up by the NDRC at the University of Pennsylvania. These tests indicated the possibility of 100 per cent Murphree plate efficiency with only 6 in. tray spacing. Trays of this general type are now contemplated on all but the very small units.

Pure gaseous oxygen and nitrogen pass from the fractionator to the reversing exchanger in which they remove heat from the fresh air feed, and then pass out of the plant to be used as desired. As the final oxygen stream passes through its own separate passage in the reversing exchanger and never through a pump or check valve, all possibility of contamination with air, oil, carbon dioxide, or water is removed. Oxygen of any desired degree of purity and at a few pounds pressure can be obtained by merely adjusting the oxygen drawoff valve, the yield varying only in proportion to the degree of purity desired. Decrease in the oxygen drawoff rate results in absolutely no upset of the unit because of the high degree of automatic control employed.

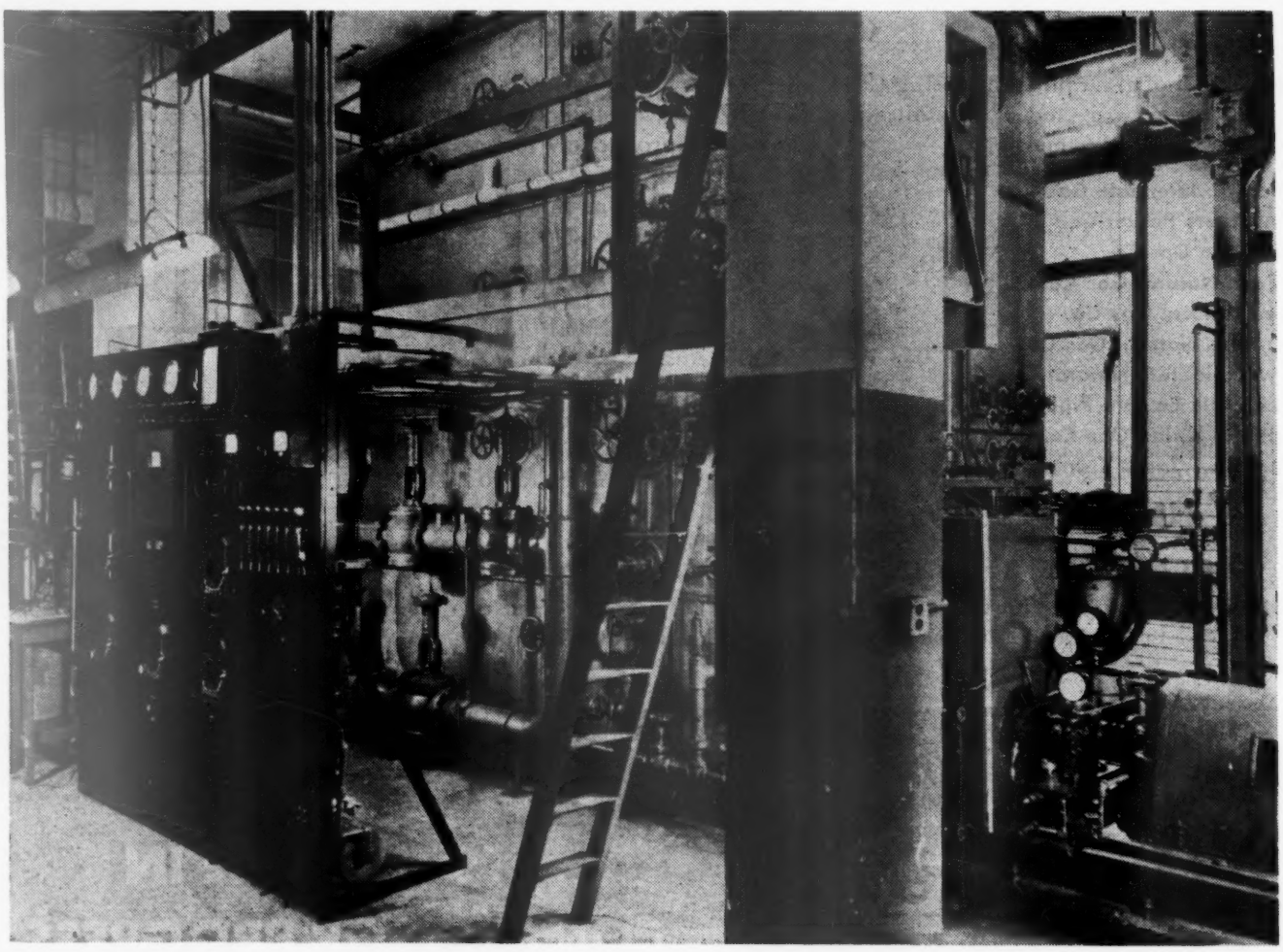
● **Rare gases.** Of the rare gases present in the air, argon, comprising about 0.8 per cent, has often been recovered since 1911 as a byproduct of oxygen manufacture. It is currently used as the inert gas in electric light bulbs. Argon boils at a temperature intermediate between that of oxygen and nitrogen, and so, in making an oxygen of 95 per cent purity, most of the argon remains in the higher boiling oxygen fraction—the split being essentially between oxygen and nitrogen. On the other hand, when making high purity oxygen (99.6 per cent) the required split is between argon and oxygen, which requires a greater number of trays in the fractionating column.

Recently, krypton, which is present in air in the exceedingly minute proportion of one part per million, has been found to be an excellent medium for filling electric light bulbs. "K-Bulbs," as they are called, give better light than argon bulbs, although they are presently much more expensive. The large size of some of the contemplated modern oxygen plants, however, may make krypton-filled electric light bulbs economically feasible, at least for specialized purposes.

The Kellogg process can be modified, if desired, to produce by-product nitrogen that could find important application as a raw material in nitric acid by the oxidation method or where inert atmospheres are desirable.

● **Plant layout and materials of construction.** In the development of the Low Pressure Oxygen Process, a great deal of attention has been directed toward studies of the best layout of the overall plant, the cold equipment, and the inter-

Large liquid oxygen pilot plant at the University of Pennsylvania. Plant is equivalent to a gaseous plant producing 21 tons per day of 96 per cent purity product.



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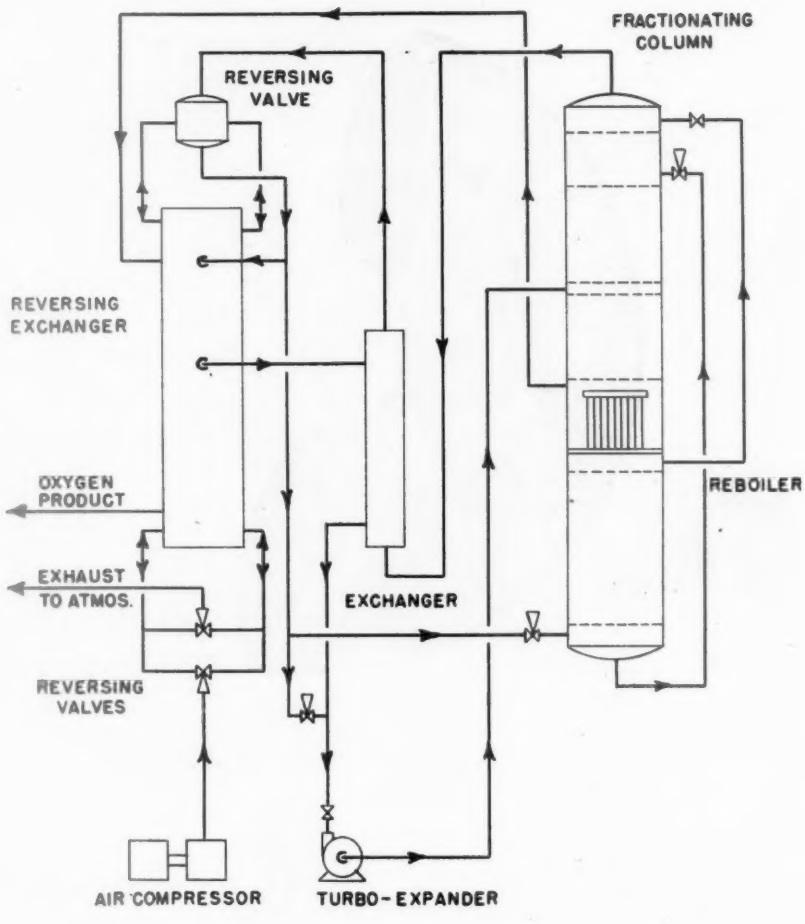
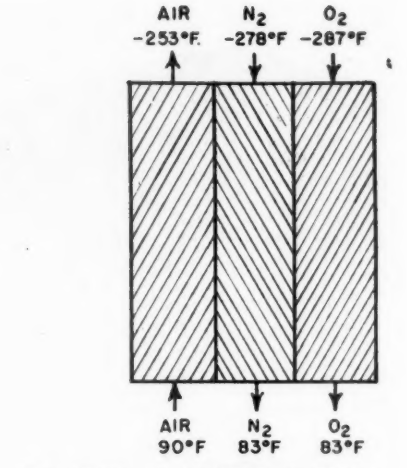
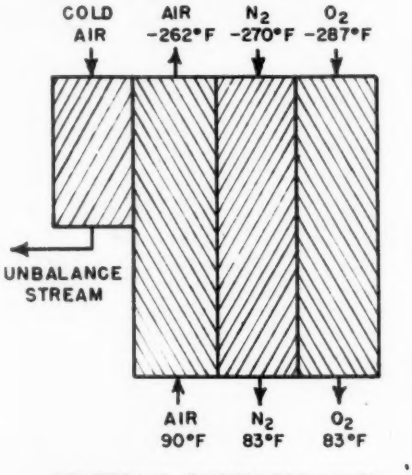


FLOW DIAGRAM OXYGEN PLANT



REVERSING EXCHANGER - WITHOUT UNBALANCE STREAM



REVERSING EXCHANGER - WITH UNBALANCE STREAM

connecting piping. Expansion problems have been considered carefully and easy access to all pieces of equipment has been a primary aim. Simplicity of design and ease of operation have been provided. Controls are few and most of them are automatic. The plant can be operated by one operator per shift and can be shut down for a few hours or a few days with no adverse results.

Construction materials in a low-temperature plant of this type are limited to the non-ferrous metals such as copper, brass, bronze, aluminum, and high chrome-nickel alloys. The unit must be made particularly tight and leak free and careful initial inspection is essential as repairs in cold equipment are difficult.

● **Space requirements.** In a plant to produce 350 tons per day of gaseous oxygen having a purity of 95 per cent, it would be necessary to compress about 30,800 std cu ft of dry air per minute. Such a plant could be completely housed in a building about 60 by 90 ft.

● **Utilities.** The main utility requirements for a plant of this size would be 55,000 lb per hr of steam (450 psi, 700 F). The cooling water requirement would be about 240 gpm. Electric power generated by the expansion engine of the process would, in many cases, be more than enough for the plant requirements.

● **Plant costs.** Plants essentially of the type described above have already been designed and built in three sizes, many of about 1¼ tons per day capacity, producing 99.5 per cent oxygen, and one liquid oxygen plant has been built equivalent to 21 tons per day of gaseous oxygen of 96 per cent purity.

In times like these, however, it is difficult to give accurate cost figures. Materials and labor are unpredictable and therefore a good figure today is inaccurate next month. Furthermore, without complete specifications, costs are meaningless. For orientation purposes, however, it might be stated that a 400 ton per day oxygen plant producing a 95 per cent purity product, might be constructed for about $2,000,000 or $5000 per ton of capacity per day. A plant to produce 100 tons per day would cost somewhat more per ton, and one for 700 tons per day somewhat less per ton, for it is obvious that plant cost per ton of capacity is influenced greatly by the size of the unit.

● **Oxygen cost.** As with plant costs, product costs vary with specific installations. The value of utilities varies with the location of the plant. Labor rates are different in different sections of the country, and various methods of accounting for fixed charges are used. Under certain conditions, however, using a figure of 3 per cent of plant cost for maintenance per year, 1½ per cent of plant cost for taxes and insurance per year, and 10 per cent depreciation per year, the total cost of producing oxygen in a 400 ton per day plant may be as little as $3.50 per ton, including all the above items plus utilities and labor charges. This is equivalent to about 15 cents per M cu ft and is a very favorable figure compared to present-day standards.

All evidence points in the direction that oxygen of the future will be cheaper and more abundant than at any time in history because of the development of the highly efficient Low Pressure Oxygen Process. A number of industrial processes that now employ air as a source of oxygen, are expected to be favorably influenced by the sharp drop in the cost of oxygen, and there is more than an indication that the techniques employed in this low pressure process may be profitably adapted to the purification of other common industrial gases.

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[1] "Oxygen by Fractionation at Low Pressures," W. E. Lobo, *Chemical Industries*, July, 1946.

[2] "Air Purification in the Reversing Exchanger," W. E. Lobo and G. T. Skaperdas, *Chemical Engineering Progress*, March, 1947.

[3] "Production of Oxygen for Industrial Purposes" W. E. Lobo, *Chemical Engineering Progress*, January, 1947.

[4] Patent not yet issued.

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Refiner still follows his will-o'the-wisp

By F. E. FISHER, Technical Director, and J. W. VAIDEN, Vice President in Charge of Manufacturing, Skelly Oil Company

SEVEN years ago a paper was delivered before the general session of the annual meeting of the Western Petroleum Refiners Association in which octane number was referred to as "The Refiner's Will-O'-The-Wisp." A quotation from this paper by W. W. Scheumann is quite pertinent to the situation as concerns octane number facing the refiner today, and shows that he is still following the will-o'-the-wisp as ineffectively as he did seven years ago. Mr. Scheumann has the following to say regarding the misuse of the octane number:

EXCLUSIVE

"... In most instances the refiner and marketer have simply ignored the facts that have been placed before them in published papers on cooperative road tests and by their own technical men. They have acted as though the octane number were an intrinsic characteristic of a gasoline instead of an arbitrary test and as though the maintaining of an octane number level insured uniform anti-knock road performance. The octane number has been included as a sales specification, as a means of establishing price brackets for gasolines, and, in general, over-emphasized. Particularly can over-emphasis be charged against sales promotion based on small octane number differences, which may or may not have been reflected in road performance.

* * *

"The most apparent result from the misuse of the octane number has been the so-called octane race. The effort of every refiner to keep the numerical value for the octane number of his gasoline equal to that of all his competitors has resulted in a steady increase in octane-number values. This, in turn, has meant a corresponding increase in cost to the oil companies with no compensating return.

* * *

"The octane number is made to order for that type of advertising which consists principally of the conspicuous posting of big numbers.

* * *

"Anti-knock quality in motor fuel is of definite economic value to the consumer. However, present engines do not use this quality most effectively and research indicates that engines could be improved in this respect. In the past, such improvements were not always made, because the refiner lavishly supplied additional anti-knock quality in his fuel to make up for such shortcomings. Only time will tell how much longer he can continue this practice."

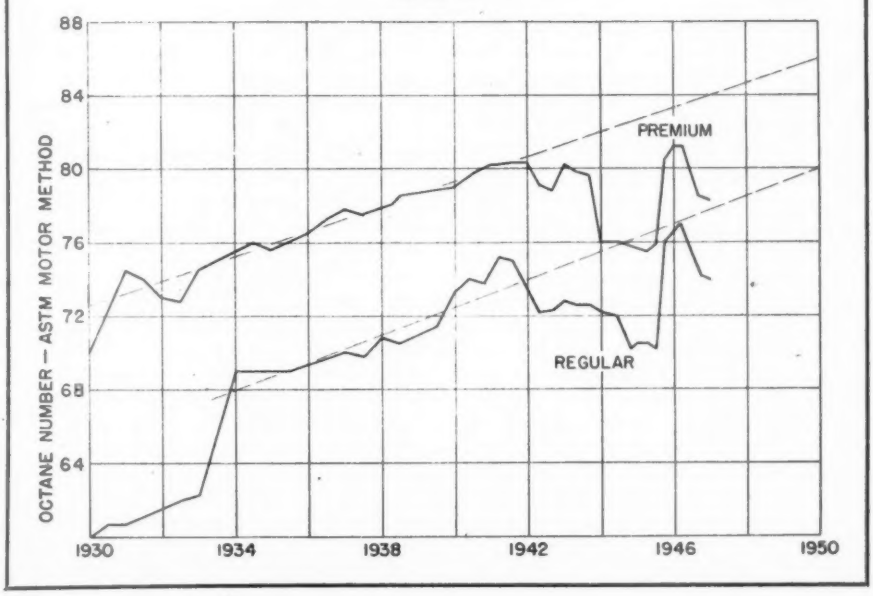
Fig. I shows quite clearly the upward trend in octane numbers of both regular and premium grade motor fuels since 1930. Had it not been for the interruption of the war years, these curves no doubt would have followed the same general rate of increase shown by the prewar years. Octane numbers increased quite sharply after the war and were depressed again only because of a shortage of tetraethyl lead that is still existent.

The petroleum refiner has demonstrated, over the years, the ability of the industry to meet and in some cases anticipate the fuel requirements of changing automotive design. We are all well aware of the fact that these requirements included not only increases in quality from several standpoints but considerable increase in quantity to satisfy the demand. This has all been accomplished without any appreciable increase in the cost of the fuel during the past decade, largely by reason of improved manufacturing processes in which increased quality was accompanied to some extent by an increase in the amount of gasoline produced per barrel of crude oil. The yield of gasoline from crude oil has about reached a maximum in the newer catalytic cracking processes, and, although significant improvement in anti-knock performance has been obtained, further increases in octane number can only be accomplished by additional processing, which must be reflected in the cost of motor fuel.

Various fractions hitherto included in motor gasoline are now in demand by other industries for use as solvents, base stock for chemical manufacture, etc. The market for butanes for domestic and industrial fuel has increased steadily and requirements for chemical manufacture are growing rapidly. In most cases, the market value of such hydrocarbons or hydrocarbon mixtures is considerably above that of motor fuel and results in the diversion of quantities of gasoline-range hydrocarbons from the motor fuel market. This not only decreases the supply of motor fuel but obviously will result in increased costs if high octane levels are maintained. The motoring public wants and is entitled to satisfactory performance from its motor car and at a minimum cost. The refiner has striven to supply a fuel that would meet such requirements and by and large has supplied a fuel of even superior quality.

The upward trend in the octane number of motor fuel since 1930, to some extent, had been justified by the corresponding increase in compression ratio of automotive engines during that period. It is generally agreed, however, that many present automobile engines have reached, or are approaching, their

FIG. 1.



maximum useful compression ratio. An increase in the octane number of motor fuel over and above that necesssary to satisfactorily operate in the present-day automobile is an economic waste.

Technical literature is profuse with articles by both refining and automotive engineers concerning motor fuels and engines and the results of many laboratory and road tests of automotive engine performance and fuel requirements. Both refinery and automotive engineers seem in agreement that improvements in performance can be made. Both seem equally agreed that the current high level in octane number is, for various reasons, unnecessary to satisfy the fuel requirements of the average car on the road or being produced today.

When high-octane number gasoline is used in a car that will operate satisfactorily on a lower octane fuel, there is no improvement in either mileage or power. It is a well-recognized fact that automobile manufacturers recommend that their engines be operated with the spark advanced to a point where a slight knock will be experienced at low speeds under full throttle opening. As the octane number of fuels available are increased, the spark is advanced accordingly, but engine performance remains practically the same over a wide range of fuel octane numbers. It has been shown that there is sometimes a very considerable difference in the octane requirements between cars of the same make and model, the result of variation in spark timing from cylinder to cylinder or of fuel mixture distribution. This is emphasized when the refiner receives the same complaint of knocking at low speed using fuels differing by as much as five octane numbers and at the same time is informed of satisfactory performance from the large majority of his fuel consumers using the same make and model of vehicle. This has been and still is a problem for the automotive engineer that has not been entirely corrected. The refiner usually hears the brunt of the customer complaints, however, as engine knock is almost always attributed to the fuel rather than to the engine or its appurtenances.

If the automobile manufacturer can correct these difficulties, a considerable reduction in motor fuel octane level would be possible. The refiner would be permitted to market a satisfactory lower octane number fuel and at a very material saving to the consumer.

One fact of definite bearing on octane number requirements of motor fuel is the apparent indifference of the average car owner to the effect of improper adjustments and neglect of maintenance of his motor-car engine, on the power mileage and general performance of his car. Too few car owners appreciate the improvement in performance and economy that can be obtained by proper adjustment and periodic checkup of their automobile power plant, particularly of the ignition and carburetion system. Automobile manufacturers and refiners alike would benefit along with the consumer if the car owner could, in some way, be convinced of the value of proper maintenance.

It was shown by Van Hartsveldt and Field in 1940 that an octane number increase from 74 to 80 would, on a basis of yield decrease, increased cracking and reforming costs, etc., increase the cost of gasoline about 5 cents per bbl. Such an increase in octane number, it was pointed out, would cost $150,000,000 per year if applied to the 500,000,000 bbl of gasoline then being produced. It was recognized that this cost might vary widely, depending upon the individual refiner's situation, but, in any event, it would quite probably be a considerable sum. With today's prices, the cost estimate of 5 cents per bbl no doubt would be materially increased. If power, mileage, or general performance were increased in relation to the octane number above a practical limit, there would be an economic advantage in marketing the higher octane fuels. From all the data presented by the numerous investigators who have studied this problem, the increase in performance obtained, if any, is quite small (in the order of 1 to 3 per cent) and the cost of the increased octane number far out of proportion to the value received.

Changes or trends in automotive engine design are of importance to the refiner just as changes in the refining industry should be of importance to the automobile manufacturer.

The introduction of new developments, whether in the automotive or refining industry, is governed largely by economic factors. Certain automotive developments must await advances by the petroleum industry. This is especially true of engine change requiring increases in anti-knock quality unless radical advantages in economics can be predicted.

The closest cooperation is required between technologists of the refining and automotive industries if progress is to be made in supplying the public the best in economical transportation. "Crystal ball gazing" during the past few years by many advertisers and quasi-technical writers has led the public to expect many new developments in their postwar automobile that have not yet materialized nor are possible until a better economic picture is obtained. Carburetors and fuel systems are expected to remain substantially the same for the next several years, and, as we have mentioned before, compression ratios are at or near their maximum for present design. Changes can be expected in manifold and combustion chamber design of new engines that may improve engine performance and reduce knocking tendencies.

Fuel injection is undergoing rather extensive study by a number of manufacturers. Limited use of manifold injection is expected, but economics do not favor widespread adoption of present developments of fuel injection systems. The successful development of such a system would have considerable effect upon fuel requirements and specifications. This is likewise true of the development of superchargers.

There is an increasing trend on the part of the refiner to recognize the value of road tests as compared with laboratory engine tests in determining the performance of a fuel. The borderline method of road testing, adopted by the Coordinating Research Council as a standard road-test procedure for gasoline in 1941, has been found of considerable value in examining fuel characteristics. Special equipment is necessary for these tests and considerable expense is involved. Results from tests using this method have demonstrated that octane number by any established laboratory test method or combination of methods does not always reflect the road performance of motor fuels. This is an important consideration for the refiner and automotive engineer alike, for it is quite possible that a fuel offering excellent road performance might not have its good characteristics reflected in laboratory octane-number tests. Testing methods for developing proper yardsticks for fuel and engine performance have been in an almost constant state of development. It is a difficult problem and one that will result to the disadvantage of the automotive and refining industries and the consumer until it is solved. In the meantime, the refiner still continues to follow his will-o'-the-wisp in the same blind, ineffectual way that he has for the last decade.

★ ★ ★

Natural Gas Rich Source of Synthetics

Comparatively recent technologic developments in the use of natural gas for purposes other than for direct fuel and energy have uncovered an important potential raw material source for hundreds of synthetic products, the Bureau of Mines reported.

Some of the better-known materials or raw material stock derived from natural gas during wartime include synthetic rubber; plastics as substitutes for rubber and silk; ammonia, glycerine, toluene, and nitroparaffins for use in explosives; and practically pure chemical products for use as anti-knock motor fuels or additives in aviation gasoline manufacture.

The number of products obtainable from natural gas already is large and the relative cheapness and availability of natural gas indicate that the range of products will continue to grow. As an indication of the further expansion of industries drawing on natural and refinery hydrocarbon gases for raw materials, many wartime plants and processes were rapidly converted to peacetime activities and new plants blueprinted for construction.

What's The Limit?

Fourteen thousand feet in the air, scientists dropped pellets of dry ice into a cloud and created a snow storm. *Now man can make snow fall where he wants it!* Will we soon create great reservoirs of moisture for arid regions by storing snow in the hills? What's the Limit?

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By **DAVIS READ** and **GUSTAV EGLOFF**, Universal Oil Products Company

EXCLUSIVE

VIRTUALLY all modern refining methods have been applied to the processing of South American crudes. By far the greatest amount of work, both in the laboratory and in commercial operations, has been carried out on crudes produced in Venezuela. This is not surprising in view of the fact that in 1946 Venezuelan crude production comprised approximately 85 per cent of the total crude produced in South America.

South American production—1946.

	Barrels (estimated)
Venezuela	388,000,000
Argentina	22,500,000
Colombia	22,250,000
Peru	12,500,000
Ecuador	2,400,000
Bolivia	375,000
Brazil	70,000
Chile	?

The variation in the quality, i.e. the gasoline and sulphur contents, of these crudes covers nearly the same range as those produced in Central and North America, so that the refining of these oils presents no unusual problems.

With the present emphasis on the development both of oil resources and refining capacity, the volume of oil from all producing countries of South America is expected to increase during the next few years. As an aid to the oil technologist, this study presents a summary of information now available on the properties of a number of South American crudes and illustrates the application of several processes to the refining of these oils.

● **Properties of crudes.** The quality of South American crudes varies considerably and in many cases the variation in the properties of crude from a given field is quite large. The information contained in Tables 1 and 2 shows the properties of one sample from each of the fields studied.

In addition to the gravity and distillation characteristics, which determine in general the yields of refined products obtainable, the sulphur and salt contents of a given crude are important factors in determining the refining procedure required to produce marketable finished products. Both sulphur and salt cause corrosion in refining equipment and in order to meet sulphur specifications on the finished products it is necessary in some cases to install extensive treating facilities.

In specifying the refining scheme for a given crude many factors must be considered in determining whether the crude should be desalted and the equipment protected from corrosion by the use of alloys. In general, for high on-stream efficiency in a refinery having average thermal cracking capacity, desalting is recommended when the salt content of the charge exceeds about 15-25 lb per 1000 bbl. Similarly, extensive corrosion protection with alloys is usually needed when the sulphur content of the cracking charge exceeds 0.7-0.8 per cent. There are, of course, many exceptions to these general rules and the economics of each situation must be studied in working out the proper refining scheme.

The eight Venezuelan crudes listed in Table 1 vary in API gravity from 16.9 to 47.5 with corresponding 400 F endpoint gasoline contents of 5.7 to 50.9 per cent. The Lagunillas crude is typical of the relatively high sulphur, asphaltic or naphthenic type of crude, whereas the Cumarebo crude is more paraffinic and contains a relatively small amount of sulphur. Note that the crudes are listed in this table in the order of decreasing sulphur content.

The properties of crudes from one or more fields of all of the other oil producing countries of South America are listed in Table 2. With the exception of the Colombian and the El Sosneado, Argentine crudes, these oils are quite low in sulphur content. The extremely high cold tests of the Itaparica and Candeais, Brazilian crudes indicate their unusually high paraffin content. Although the data available on the salt contents of these oils are somewhat limited, the Itaparica, Brazilian crude is the only one of the samples tested that contained an excessive amount of salt.

● **Crude distillation.** Tables 3 and 4 show the yields and properties of the fractions obtained in laboratory distillation of samples of the various crudes. Most of the samples were fractionated to produce 400 F endpoint gasoline, kerosine, gas oil, and reduced crude in 800 ml Hempel distillations, although in some cases only the gasoline was removed in the distillation. In the past the usual commercial practice has been to produce a 400 F endpoint straight run gasoline, which after treatment was sold directly, or blended with cracked gasoline, for sale as motor fuel. With the recent trends toward higher octane ratings of finished motor fuel much information has been obtained on the effect of "under cutting," or decreasing the gasoline endpoint, on its octane number. Fig. 1 shows the effect of undercutting on the F-2 or motor method octane numbers of gasoline from 12 South American crudes. Similar data on three crudes are plotted on Fig. 2 to show the relationship between the endpoint and the F-2 octane rating of the gasolines after the addition of 3cc per gal of tetraethyl lead. The corresponding yields expressed as volume per cent of the crude are plotted versus gasoline endpoint on Fig. 3.

● **Preparation of feed stock for cracking. Thermal cracking.** No special feed preparation steps are required for thermal cracking, other than salt removal in

TABLE 1. Properties of Venezuelan crude oils.

Field	Lagunillas	La Rosa	Temblador	Oficina	Colon	Jusepin	"Western"*	Cumarebo
Crude oil								
Gravity, °API	16.9	23.3	32.0	22.3	31.4	33.4	38.7	47.5
Specific gravity at 60 F.	0.9535	0.9141	0.8654	0.9200	0.8686	0.858	0.8314	0.7905
Per cent total sulphur	2.37	1.70	1.0	0.90	0.89	0.55	0.23	0.11
B. S. & W., per cent	0.4	0.1		0.1	0.4	0.4	Trace	0.2
Salt as sodium chloride, lb/1000 bbl	None		5	10				
Cold test, F	Below 0	Below 0	10	Below 0	Below 0	Below 0 (500 ml distillation)	Below 0	30
100 ml distillation								
Initial boiling point, F	215	166	120	210	150	77	110	122
5 per cent	350	274	200	333	222	200	160	164
10 per cent	445	336	255	401	282	255	184	198
20 per cent	572	466	320	493	382	350	234	242
30 per cent	646	572	390	558	484	447	280	288
40 per cent	675	648	490	622	572	535	348	350
50 per cent	692	684	580	670	654		444	408
60 per cent	700	703		697	688		512	483
70 per cent				707	704		586	538
80 per cent				718	712		670	610
90 per cent				724	716		730	698
Per cent over	89.5	92.0		92.5	93.5		98.5	97.5
Per cent bottoms								1.1
Per cent loss								
Per cent coke by weight	10.7	8.0		7.4	6.5		1.3	

*Exact field or fields not known.

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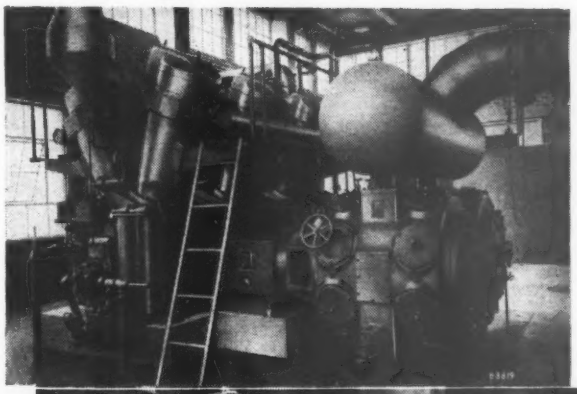

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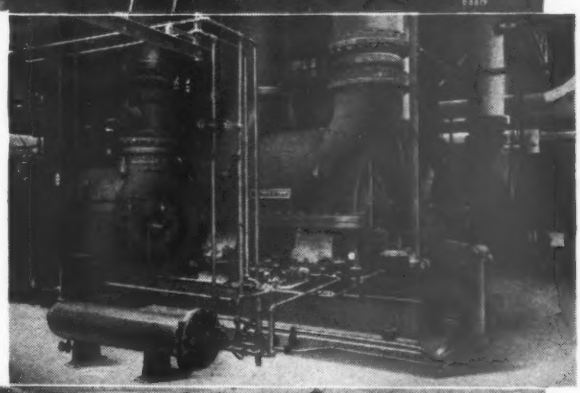

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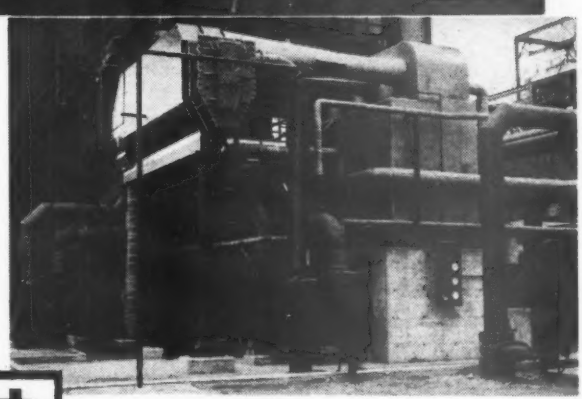

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TABLE 2. Properties of crudes from Argentina, Colombia, Peru, Ecuador, Bolivia, Brazil, and Chile.

District	Argentina		Colombia*	Peru			Ecuador	Bolivia		Brazil		Chile†
Field	El Sosneado	Comodoro Rivadavia		Lobitos	El Condor	Agua Caliente	Santa Elena	Sanandita	Camiri	Itaparica	Candeais	
Crude oil												
Gravity, API	11.2	28.0	25.0	36.7	37.2	43.9	41.2	41.7	54.7	34.1	29.0	39.2
Specific gravity at 60 F	0.9916	0.8871	0.9042	0.8413	0.8388	0.8067	0.8193	0.8170	0.7599	0.8540	0.8816	0.8289
Per cent total sulphur	1.26	0.09	0.82	0.07		0.07	0.05	0.07	0.02	0.07	0.10	0.05
B. S. & W., per cent	0.7	..	..	Trace		0.2	None	..	..	..	..	..
Universal viscosity at 100 F, sec	..	249	174	..		36.5	..	..	..	..	..	38.5
Furol viscosity at 122 F, sec	1178	..	..	..	..	..	..	..	..	..	..	..
Universal viscosity at 122 F, sec	..	..	..	..	..	..	..	..	..	68.4	268	..
Cold test, F	55	..	Below 0	10	..	50	Below 0	..	..	85	90	80
Salt as sodium chloride, lb/1000 bbl	..	..	..	..		None	..	None	None	500	3	2.5
100 ml distillation												(200 ml dist.)
Initial boiling point, F	266	215	210	176	160	132	142	116	110	212	220	155
5 per cent	400	291	294	238	212	186	198	180	142	290	340	222
10 per cent	586	334	361	269	240	224	238	218	174	350	412	276
20 per cent	650	427	490	330	294	284	290	282	202	468	566	352
30 per cent	672	520	585	386	350	352	346	351	250	552	660	424
40 per cent	688	617	650	465	420	424	410	442	286	615	677	487
50 per cent	699	682	694	535	494	502	478	518	328	686	697	532
60 per cent	718	704	720	605	575	570	544	586	387	714	705	601‡
70 per cent	740	721	725	688	654	655	615	658	448	729	718	664‡
80 per cent	746	736	735	744		705	686	724	518	740	735	758‡
90 per cent			745			727	714	752	648	753		898‡
Per cent over	86.5	92.0	93.5	99.0	98.5	97.0	98.5	98.5	98.5	96.0	93.5	97.0
Per cent coke by weight	13.1	7.4	5.5	1.2	1.6	2.2	1.4	1.2	1.5	3.7	6.8	..
Per cent bottoms												2.0

*Sample believed to have been obtained from the LaCira field.
†Data supplied by Foster Wheeler Corporation.
‡Crude distillation temperatures obtained under 10 MM vacuum and converted to atmospheric pressure.

some cases. Any of the heavier fractions of the crudes such as the kerosine, gas oil, or the reduced or topped crude, listed in Tables 3 and 4, can be thermally cracked to increase the overall gasoline yield from crude.

When asphalt or lube oils are to be produced, the refinery scheme is usually arranged to include vacuum flashing of the reduced crude from the crude distillation unit. The vacuum unit produces overhead gas oil fractions for use in lube oil manufacture and crude residue that may be blended with other fractions to produce asphalt of the required specifications. The lighter fractions from the crude distillation unit and the excess heavy vacuum gas oil that is not used in lube oil manufacture can then be thermally cracked.

● **Fluid catalytic cracking.** Kerosines, gas oils, and some types of topped crudes can be charged as liquids to a fluid catalytic cracking unit. The stocks should be free of salts, which poison the catalyst, and should preferably be relatively low in Conradson carbon content. The latter requirement eliminates the consideration of most topped or reduced crudes as charging stock for catalytic cracking, for the coke-forming tendencies of these residual oils are usually quite high and the regeneration requirements for the catalytist are excessive. Topped crudes having Conradson carbon contents of 1.0-2.0 per cent have been successfully processed in commercial fluid catalytic cracking units, but these are unusually clean topped crudes. There are four well known methods that may be employed for the preparation of feed stocks for catalytic cracking from reduced or topped crudes:

1. Vacuum flashing
2. Viscosity breaking
3. Propane deasphalting
4. Thermal coking

TABLE 3. Composition of Venezuelan crudes.

Field	Lagunillas	La Rosa	Temblador	Oficina	Colon	Jusepin	"Western"	Cumarebo
Straight run gasoline								
Volume per cent of crude	5.7	16.0	12.1	31.0	22.2	24.0	49.1	50.9
Gravity, °API	55.2	56.9	52.2	56.5	58.8	58.9	57.0	62.7
Specific gravity at 60 F	0.758	0.7511	0.7703	0.7527	0.7436	0.743	0.7507	0.7286
Per cent total suphur	Below 0.1	Below 0.1	0.03	0.02	0.03		0.02	0.02
Per cent mercaptan sulphur			<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Reid vapor pressure, lb			4.7					
Octane numbers								
F-2 (Motor) clear		55	65.5	57	46	60	68	54
F-2+3cc TEL/U.S. gal				78				
100 ml distillation								
Initial boiling point, F	140	118	116	105	134	108	110	104
10 per cent		190	195	173	190	171	152	150
30 per cent		230	249	226	242	226	195	210
50 per cent		272	286	266	280	271	238	246
70 per cent		310	320	305	294	305	280	290
90 per cent		346	364	353	354	359	344	356
Endpoint, F	380	402	400	400	398	395	400	394
Kerosine								
Volume per cent of crude	..	..	17.7	..	13.6	10.0	..	..
Gravity, °API	..	..	33.8	..	41.9	41.0	..	..
Specific gravity at 60 F	..	..	0.8560	..	0.8160	0.8205	..	..
Per cent total sulphur	..	..	0.18	..	0.15	..	..	..
Smoke point MM	..	..	..	..	23	24	..	..
Flash point Tag closed cup,F	..	..	..	..	100	..	..	..
Viscosity SSU at 100 F, sec	..	..	34.5	..	..	..	..	..
100 ml distillation								
Initial boiling point, F	..	..	410	..	310	364	..	..
10 per cent	..	..	441	..	387	397	..	..
50 per cent	..	..	475	..	456	431	..	..
Endpoint, F	..	..	567	..	542	517	..	..
Gas oil								
Volume per cent of crude	14.7	..	..	..	21.9	21.5	..	..
Gravity, °API	33.0	..	..	..	32.8	33.1	..	..
Specific gravity at 60 F	0.860	..	..	..	0.8612	0.8595	..	..
Per cent sulphur	0.60	..	..	..	0.75	0.19	..	..
Cetane no, Delay Method	..	..	..	..	60	..	..	..
Cold test, F	..	..	..	..	35	20	..	..
Viscosity SSU at 100 F	..	..	..	..	55	..	..	..
Characterization factor	..	..	..	..	12.0	..	..	..
100 ml distillation								
Initial boiling point, F	406	..	..	..	524	453	..	..
10 per cent	..	..	..	..	560	495	..	..
30 per cent	..	..	..	..	598	522	..	..
50 per cent	..	..	..	..	624	552	..	..
70 per cent	..	..	..	..	670	592	..	..
90 per cent	..	..	..	..	732	660	..	..
Endpoint, F	..	..	..	..	750	..	..	..
Topped or reduced crude								
Volume per cent of crude	79.6	83.8	70.0	69.0	42.1	44.5	52.1	48.9
Gravity, °API	11.9	18.3	15.8	23.0	18.7	19.3	24.1	35.4
Specific gravity at 60 F	0.987	0.9446	0.9606	0.9159	0.9421	0.938	0.9094	0.8478
Per cent sulphur	2.8	1.9	1.21	1.4	1.57	1.18	0.35	0.15
Cold test, F	..	..	10	..	45	90	30	65
Viscosity SSF at 122 F, sec	1050	..	134	20	230	120	..	..
Characterization factor	11.45	..	11.53	11.7	11.8	11.8	11.5	11.8

It appears at present that vacuum flashing has the greatest application as a means of preparing feed stock for fluid cracking in the average smaller refinery. The installation and operating costs for viscosity breaking are competitive with vacuum flashing, but it is, of course, not possible to produce straight run asphalts and the heavier lubricating oils when the reduced crude is subjected to viscosity breaking temperatures.

Propane deasphalting may be advan-

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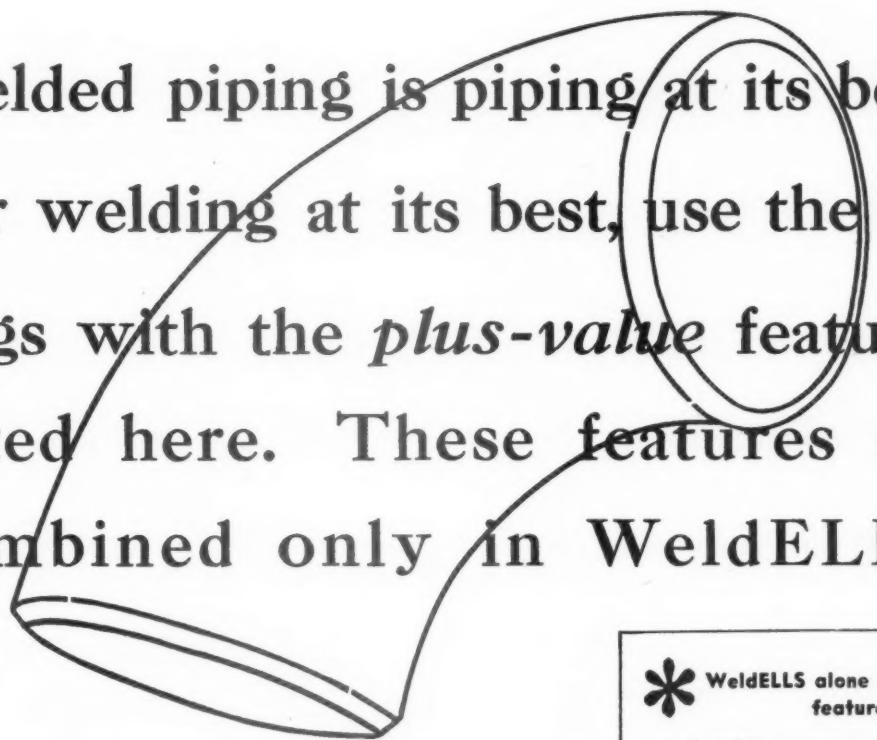

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TABLE 4. Composition of crudes from Argentina, Colombia, Peru, Ecuador, Bolivia, Brazil, and Chile.

District	Argentina	Colombia	Peru			Ecuador	Bolivia		Brasil				Chile†	
Field	Comodora Rivadavia	La Cira	Lobitos	El Condor	Agua Caliente	Santa Elena	Sanandita	Camiri	Itaparica		Candeais		Light gasoline	Naphtha
Straight run gasoline														
Volume per cent of crude	9.7	14.4	34.0	37.7	39.0	40.2	37.2	65.1	16.8		9.9		11.15	16.77
Gravity, °API	62.5	55.3	57.1	55.0	64.0	57.6	62.1	65.3	59.6		58.4		64.0	48.7
Specific gravity at 60 F	0.7294	0.7575	0.7503	0.7587	0.7238	0.749	0.7309	0.7190	0.7405		0.7451		..	..
Per cent total sulphur	0.02	0.02	0.02		0.02	0.01	0.03	0.01	0.01		0.02		0.009	0.027
Per cent mercaptan sulphur	<0.0003		<0.0003		<0.0003	<0.0003	0.018	0.002	<0.0003		<0.0003		..	..
Reid vapor pressure, lb		4.1			5.4				6.8		5.9		6.0	0.1
Octane numbers														
F-2 (Motor) clear	42	62	60	57	38.5	54	50	45	32.5		44.5		65.8	30.1
F-2 + 3cc TEL/U. S. gal					65.5				60.5		68.0		80.2	44.2
100 ml distillation														
Initial boiling point, F	143	104	148	138	112	110	96	103	100		132		116	274
10 per cent	196	191	194	205	162	172	150	153	189		204		156	309
30 per cent	220	245	235	241	218	227	208	206	252		248		176	321
50 per cent	237	275	255	270	264	262	248	247	290		281		191	333
70 per cent	255	306	290	303	307	302	290	291	320		311		208	350
90 per cent	285	352	328	352	360	346	343	345	363		360		226	376
Endpoint, F	324	400	389	401	400	402	392	392	399		399		256	402
Kerosine														
Volume per cent of crude	20.2	1.6	..	..	14.5	15.0	12.0	16.4	8.0		7.4		24.7	
Gravity, °API	46.9	41.5	..	..	44.6	42.0	41.2	44.0	46.1		45.2		39.7	
Specific gravity at 60 F	0.7932	0.8179	..	..	0.8035	0.816	0.8193	0.8063	0.7967		0.8008		..	
Per cent total sulphur	0.02	0.06	..	..	0.03	0.03	0.03	0.02	0.02		0.03		0.023	
Smoke point, MM					31				26		25		..	
Per cent mercaptan sulphur					Sweet	Sweet		0.001	Sweet		Sweet		..	
Flash point Tag closed cup, F					158	165	155	175	126		139		206	
Viscosity SSU at 100 F, sec	32.6	28.6	..	..	33	..	32.1	32.4	32.0		32.0		34	
100 ml distillation														
Initial boiling point, F	323	353	..	..	418	399	406	422	402		397		437	
10 per cent	352	364	..	..	450	413	422	428	429		413		452	
50 per cent	403	385	..	..	472	436	444	454	457		443		478	
90 per cent	479	427	..	..	508	479	489	506	490		489		523	
Endpoint, F	525	460	..	..	529	524	530	545	523		523		548	
									Light gas oil	Heavy gas oil	Light gas oil	Heavy gas oil		
Gas oil														
Volume per cent of crude	4.9	25.1	..	..	38.5	..	24.9	11.7	14.1	41.9	7.7	39.0	26.8	
Gravity, °API	36.2	31.7	..	..	34.1	..	34.8	35.7	40.3	33.1	39.0	32.5	35.4	
Specific gravity at 60 F	0.8438	0.8670	..	..	0.8545	..	0.8509	0.8463	0.8236	0.8597	0.8299	0.8628	..	
Per cent sulphur	0.05	0.35	..	..	0.11	..	0.05	0.04	0.08	0.08	0.07	0.07	0.07	
Cold test	Below 0	Below 0	..	..	85	..	35	25	20	110	25	110	60	
Viscosity SSU at 100 F	37.8	39.5	..	..	..	..	42.9	42.8	38.5	..	39.6	..	49.2	
SSU at 122 F	..	..	..	..	57.7	..	..	..	..	..	..	..	..	
Characterization factor	11.8	11.6	..	..	12.3	..	11.92	11.97	12.2	12.5	12.2	12.5	..	
100 ml distillation					(Vac. Dist)									
Initial boiling point, F	487	438	..	..	542	..	515	535	505	546	503	604	576	
10 per cent	504	468	..	..	606	..	540	551	522	695	527	681	600	
30 per cent	514	501	..	..	664	..	561	567	536	750	542	740	613	
50 per cent	522	533	..	..	727	..	585	582	549	795	554	787	628	
70 per cent	533	573	..	..	795	..	614	603	567	845	570	825	646	
90 per cent	554	621	..	..	865	..	653	639	599	912	603	882	677	
Endpoint, F	583	672	..	..	910	..	682	678	634	936	636	902	698	
Topped or reduced crude														
Volume per cent of crude	65.1	57.9	65.0	61.8	8.0	44.7	25.6	6.4	19.2		36.0		20.1	
Gravity, °API	18.9	15.9	28.9	28.2	11.9	29.5	24.7	28.2	15.0		15.0		28.4	
Specific gravity at 60 F	0.9408	0.9600	0.8822	0.8860	0.9866	0.8789	0.9059	0.8860	0.9659		0.9659		..	
Per cent sulphur	0.14	1.28	0.10		0.27	0.06	0.13	0.06	0.18				..	
Cold test, F	50	10	Below 0	Below 0		65	95	90	124*		123*		110	
Viscosity SSF at 122 F	339	1200	..	15	..	15	..	..	..		..		..	
Characterization factor	12.0	11.75	11.9	12.0	..	12.0	12.1	12.2					..	

*Softening point, ring and ball, F.
†Data supplied by Foster Wheeler Corporation.

tageous in some cases where maximum gasoline and minimum overall heavy fuel oil yields are required but the installation and operating costs per barrel of charge stock are somewhat higher than the corresponding costs for vacuum flashing. Propane deasphalting may also have the advantage, however, of permitting the production of superior lubricating oils that could not be produced by vacuum flashing. Certain types of reduced crudes are cracked slightly even at the relatively low temperatures employed in vacuum flashing, and the overhead products from such an operation are usually unsuitable for lubricating oil manufacture.

The thermal coking of reduced crude to produce coke distillate that is subsequently cracked in a field catalytic unit is being carried out commercially at present. This operation is again more expensive than vacuum flashing, but in areas where there is a good market for coke and little demand for heavy fuel oils, consideration must be given to this method of feed preparation.

As an example of one of the methods of feed preparation the results of a pilot plant continuous vacuum flash distillation of Lagunillas, Venezuela reduced crude are given in Tables 5 and 6. The 12.7°API gravity reduced crude was flashed at an oil pressure of approximately 35 mm Hg in three separate tests at the successively higher flash tower top temperatures of 590 F, 630 F, and 675 F. Note that the sulphur content of the overhead gas oil increased from 1.53 to 1.94 per cent and its Conradson carbon content increased from 0.08 to 0.46 per cent as the depth of flashing was increased.

● **U.O.P. fluid catalytic cracking.** The U.O.P. catalytic cracking process can be operated to produce high octane number motor fuel, aviation gasoline components, and raw materials for the production of synthetic rubber. The conditions of operation for the manufacture of motor fuel are somewhat different from those required for the production of aviation gasoline components. In general, it is desired to minimize the olefinic hydrocarbon content of aviation gasoline, whereas mono-olefins are a desirable constituent of motor fuels.

During the war aviation gasoline was composed largely of base stock, which was produced in a catalytic cracking unit, alkylate and isopentane. The olefin content of the base stock was minimized by operation of the catalytic cracking unit at relatively low temperatures using synthetic cracking catalysts in the single stage units, and by retreating or passing the first stage gasoline through a second reaction zone in the two-stage units.

At present the fluid catalytic cracking units are being operated, in some cases, at somewhat higher temperatures using acid treated clays or synthetic catalysts

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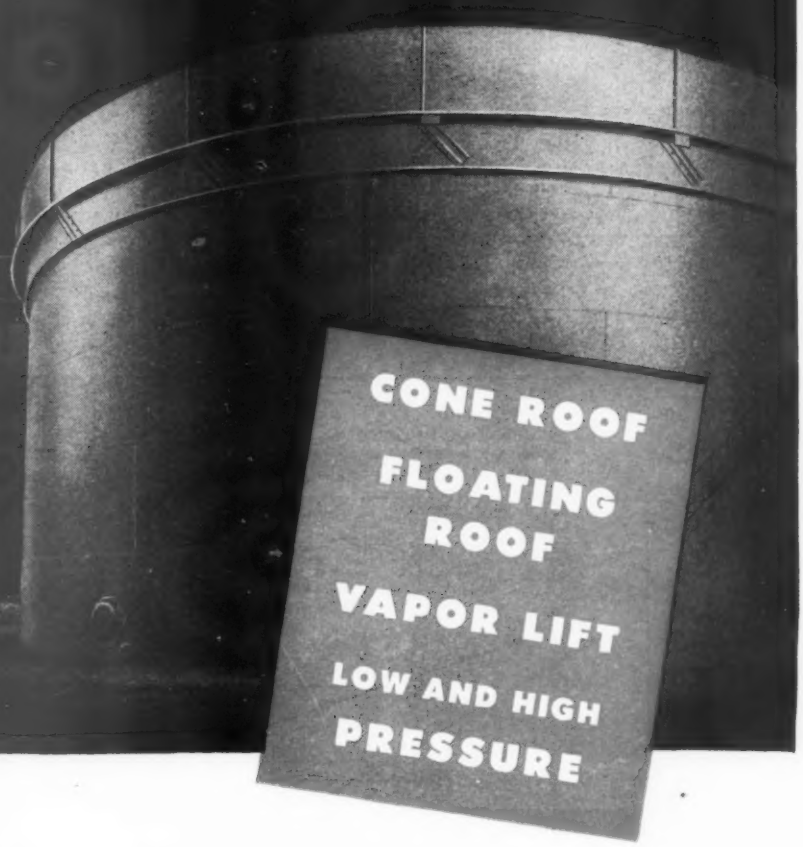

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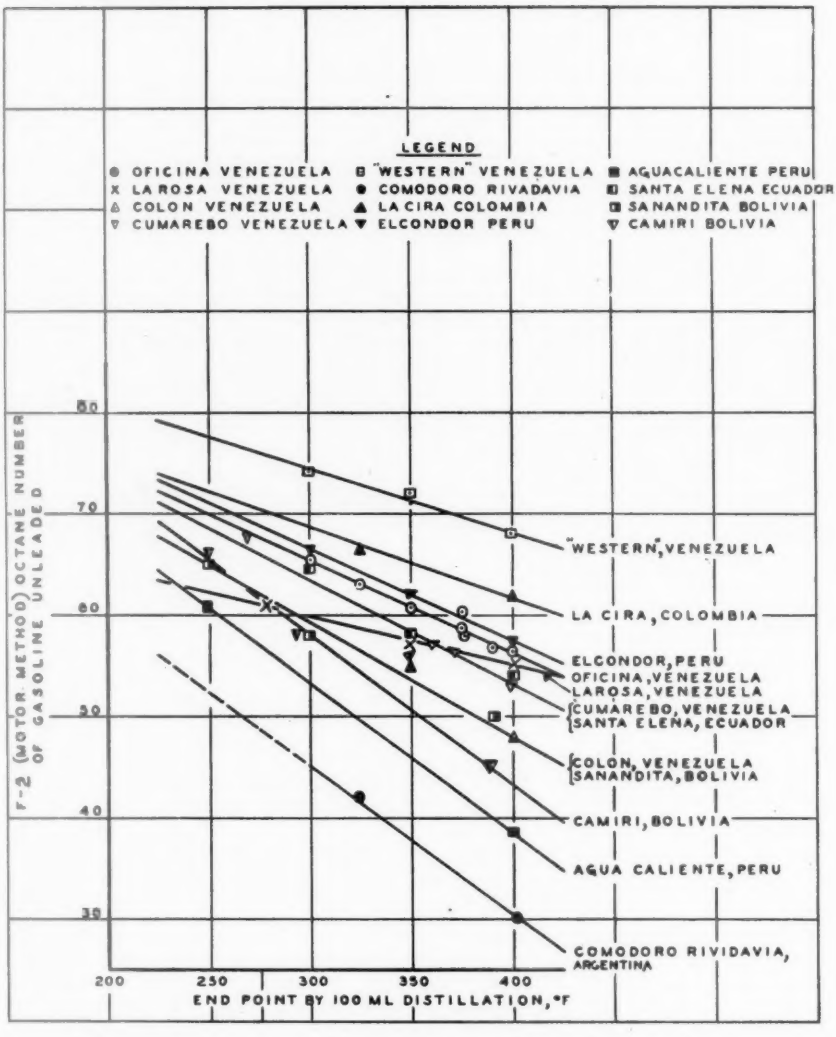

FIG. 1. F-2 (motor method) octane number-end point relationship of various South American straight-run gasolines.

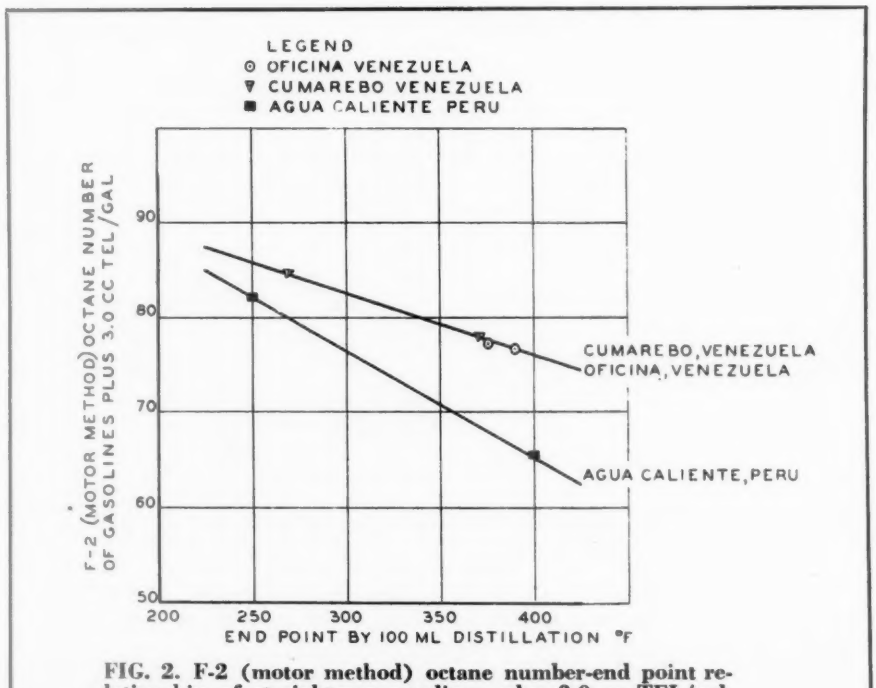

FIG. 2. F-2 (motor method) octane number-end point relationship of straight-run gasolines, plus 3.0 cc TEL/gal.

to produce more olefinic motor fuels. The aviation gasoline produced contains little or no olefins since it is composed largely of low endpoint straight run gasoline, alkylate, and isopentane.

The results obtained by fluid catalytic cracking the 20.9°API gravity heavy Lagunillas, Venezuela, gas oil, which was described in Table 6, are given in the first columns of Tables 7 and 8. The Lagunillas gas oil was catalytically cracked in once-through operation at an intermediate conversion level of 56.4 per cent (100 vol. charge minus recycle stock) and produced 44.6 per cent of 80.6 F-2 octane number debutanized motor fuel. The butylenes and propylene produced can be polymerized to increase the motor fuel yield or utilized to alkylate isobutane in the production of aviation or motor gasoline as described later.

Note that even though the charge stock contained 1.94 per cent sulphur, the gasoline was low in mercaptan sulphur and contained 0.19 per cent total

TABLE 5. Vacuum flash distillation of Lagunillas, Venezuela, reduced crude.

Properties of charge stock

Properties of charge stock	
Volume per cent of crude oil, approx.	80–85
Gravity, °API	12.7
Specific gravity, at 60 F	0.9813
Sulphur, wt per cent	2.55
Pour point, F	10
Cold test, F	5
Furol viscosity, at 122 F	605
Characterization factor	11.45
100 ml distillation	
Initial boiling point, F	482
5 per cent	585
10 per cent	640
20 per cent	742
30 per cent	815
40 per cent	865
50 per cent	950
60 per cent	1030

TABLE 6. Vacuum flash distillation of Lagunillas, Venezuela, reduced crude.

Yields and properties of fractions

Test no.	1	2	3
Overhead fractions			
Yield, volume per cent of reduced crude	38.0	44.8	55.4
Gravity, °API	23.3	21.9	20.9
Specific gravity, at 60 F	0.9141	0.9224	0.9285
Sulphur, wt per cent	1.53	1.60	1.94
Pour point, F	—25	—20	—30
Cold test, F	—30	—25	—35
Pensky Martens flash point, F.	205	230	145
Conradson carbon, wt per cent	0.08	0.17	0.46
Universal viscosity at 100 F, sec	83	122	171
Characterization factor	11.41	11.41	11.42
100 ml distillation*			
Initial boiling point, F	410	436	410
5 per cent	483	500	498
10 per cent	523	550	565
30 per cent	625	658	680
50 per cent	687	725	759
70 per cent	748	785	818
90 per cent	825	860	903
95 per cent	859	900	952
Per cent recovery	98.0	95.0	97.0
Per cent bottoms and coke	2.0	5.0	3.0
Bottoms fractions			
Yield, volume per cent of reduced crude	62.0	55.2	44.6
Gravity, °API	7.6	5.7	1.3
Specific gravity at 60 F	1.0172	1.0313	1.0655
Softening point, ball and ring, F	97	114	138
Road oil viscosity at 210 F, sec	83	195	840
Sulphur, wt per cent	3.07	2.99	3.27

*By vacuum distillation at 2-3 mm Hg converted to atmospheric temperature.

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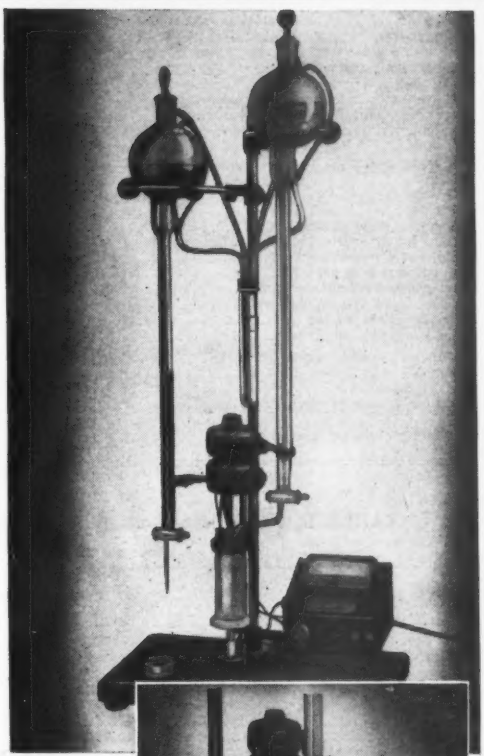

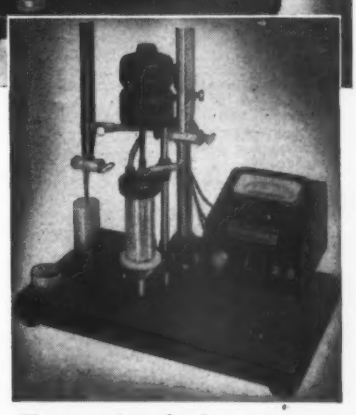

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sulphur. The olefin content of the gasoline was 40 per cent by weight, which accounts for its high sensitivity, or spread between the motor and research method octane ratings, of 11.4 numbers. In some areas the research method octane rating is becoming more important than the motor method, for it correlates more satisfactorily with road performance of passenger cars, particularly under conditions of low speed knocking, than the motor method. The catalytic cracking process is well adapted to the production of fuels with high research method ratings as the data illustrate.

Of considerable importance in evaluating the fluid catalytic cracking process is the fact that it is possible to upgrade heavy distillate oils, which can be sold only as bunker fuels, into lower boiling fractions that can be blended for sale as light distillate fuels. This is illustrated by the data in Table 8, which show that in addition to high octane number motor fuel, 43.6 per cent of the Lagunillas heavy gas oil, which has a 50 per cent distillation point of 759 F, was converted to cycle stock having a 50 per cent point of only 549 F. In other words, about 70 per cent of the cycle stock produced in this operation will meet the No. 2 fuel oil distillation specifications.

As pilot plant data on the catalytic cracking of other South American oils are somewhat limited, typical results on both a low sulphur Mid-Continent gas oil and a high sulphur West Texas gas oil are also included in Tables 7 and 8. These operations were each carried out at high conversion by recycling a portion of the cycle stock in order to increase the gasoline yield.

The 29.4°API gravity Mid-Continent gas oil produced 66.5 per cent of debutanized gasoline having a motor method octane rating of 78.3 at a conversion level of 79.8 per cent. The West Texas gas oil produced 54.9 per cent of debutanized gasoline having a similar octane rating at a conversion of 72.9 per cent.

These data illustrate the flexibility of the process, in that it is possible to recycle the fractions boiling above the gasoline range when the production of distillate fuels is not advantageous. The cost of operating at high conversion is greater than that at low conversion, however, so that the conversion level at which a given unit is operated is dictated by economic considerations.

TABLE 7. U.O.P. fluid catalytic cracking, various gas oils.

Properties of charge stocks and yields

Properties of charge stocks	Lagunillas, Venezuela	Mid-Continent, United States	West Texas, United States
Source			
Volume per cent of crude	46	38	44
Position in crude, per cent	18-64	52-90	38-82
Gravity, °API	20.9	29.4	28.4
Specific gravity at 60 F	0.9285	0.8794	0.8849
Sulphur, wt per cent	1.94	0.37	1.87
Cold test, F	−35	70	65
Conradson carbon, wt per cent	0.46	0.50	0.11
Universal viscosity at 100 F, sec	171	91.7	54.7
Characterization factor	11.42	12.01	11.65
100 ml distillation (Vacuum converted to atmospheric temperature)			
Initial boiling point, F	410	510	435
10 per cent	565	600	490
30 per cent	680	657	578
50 per cent	759	722	660
70 per cent	818	791	746
90 per cent	903	880	832
Yields, per cent of cracking unit charge			
Ethane and lighter hydrocarbons, cu ft/bbl of charge	208	222	205
Propylene, liquid volume per cent	5.5	5.0	4.4
Propane, liquid volume per cent	3.0	1.8	2.1
Isobutylene, liquid volume, per cent	1.4	1.6	1.2
N-butylenes, liquid volume per cent	2.9	5.3	4.5
Isobutane, liquid volume per cent	3.6	4.2	3.0
N-butane, liquid volume per cent	1.0	2.3	1.3
400 F endpoint gasoline, volume per cent			
Debutanized basis	44.6	66.5	54.9
10-lb RVP basis	47.0	71.4	58.7
Cycle stock, volume per cent	43.6	20.2	27.1
Operation	Once through	Recycle	Recycle
Conversion (100 volume per cent charge stock)	56.4	79.8	72.9

TABLE 8. U.O.P. fluid catalytic cracking, various gas oils.

Properties of products

Source of charge stock	Lagunillas, Venezuela	Mid-Continent, United States	West Texas, United States
Properties of products			
Composition of ethane and lighter hydrocarbons, mol per cent			
Hydrogen	50	46	40
Methane	22	32	34
Ethylene	6	7	7
Ethane	22	15	19
Total	100	100	100
Debutanized 400 endpoint gasoline (untreated)			
Gravity, °API	53.4	57.6	55.0
Specific gravity at 60 F	0.7653	0.7483	0.7587
Total sulphur, wt per cent	0.19	0.05	0.19
Mercaptan sulphur, per cent	0.002	0.004	0.003
Reid vapor pressure, lb	5.1	5.5	5.5
Oxygen bomb induction period, min	395	..	..
Octane numbers			
F-2 (Motor Method) clear	80.6	78.3	78.6
+3.0cc TEL/gal	84.2	83.5	82.7
F-1 (Research Method) clear	92.0	88.7	89.4
+3.0cc TEL/gal	95.3	95.8	94.0
Composition, wt per cent (PONA analysis)			
Paraffins and naphthenes	32	33	34
Olefins	40	52	43
Aromatics	28	15	23
100 ml distillation			
Initial boiling point, F	125	110	110
10 per cent	155	146	153
50 per cent	250	245	249
90 per cent	368	360	364
End point, F	405	400	398
Cycle stock			
Gravity, °API	16.9	25.1	24.3
Specific gravity at 60 F	0.9535	0.9036	0.9082
Cold test, F	Below −30	20	10
Universal viscosity at 100 F, sec	40.4	34.0	35.4
Sulphur, wt per cent	Approx. 1.9	0.46	1.54
100 ml distillation			
Initial boiling point, F	435	445	437
5 per cent	466	466	450
10 per cent	480	476	456
30 per cent	512	502	477
50 per cent	549	533	503
70 per cent	600	574	540
90 per cent	691	639	622

● **U.O.P. thermal cracking.** Although a considerable amount of information has been published on the thermal cracking of South American stocks, typical results obtainable by the use of this process are given in Tables 9 and 10 in order to complete the present discussions.

The U.O.P. thermal cracking process has been used extensively to convert heavy residual oils into gasoline and Bunker fuels for many years. It is simple and economical to operate, but the quality of the gasoline produced by this process is not as high as that obtained by catalytic cracking. Unfortunately, comparable data on the thermal and catalytic cracking of the same South American oils are not available, but in general, tests on other stocks have shown that the motor method octane rating of catalytic gasoline is 8-10 points higher than the octane number of thermal gasoline produced from the same gas oil charge.

The data presented in Tables 9 and 10 show that the 16.5°API gravity Temblador, Venezuela, reduced crude produced 31.3 per cent of 74-octane number gasoline and 65.5 per cent of Bunker fuel having a Furol viscosity of 224 seconds at 112 F. Similar tests on the 24.6°-API gravity Sanandita, Bolivia, reduced crude produced 52.4 per cent of 65-octane number gasoline and 40.2 per cent of 303 SSF at 122 F Bunker fuel. The Temblador reduced crude is quite naphthenic as indicated by its relatively low characterization factor and, hence, it

produces a gasoline having a considerably higher octane number than the more paraffinic Sanandita reduced crude.

The effect of varying the residuum quality on the yields in the thermal cracking operation is illustrated in Fig. 4. The data obtained in these tests on the Sanandita reduced crude are plotted versus the API gravity of the residuum on this graph. As the residuum gravity is decreased the gasoline yield increases and the residuum yield decreases. The cold test and viscosity of the residuum increases with decreasing residuum gravity as would be expected.

● **U.O.P. thermal reforming.** The U.O.P. thermal reforming process has been used extensively in all parts of the world to convert low grade naphtha and gasolines into motor fuel. As the catalytic cracking catalysts that are used for heavy oil cracking are not suitable for fluid catalytic reforming, it appears that even in refineries where catalytic cracking is installed the thermal reforming process will still have utility. This is particularly true when crudes containing low octane number naphthas are being processed.

An example of the reforming of a low octane number Argentina 250-385 F straight run naphtha is given in Tables 11 and 12. The tabular data show that the 38 motor method octane number naphtha was reformed to produce a yield of 85.0 per cent of 66-octane number 10-lb RVP gasoline that contained a small amount of mercaptan sulphur and only 0.01 per cent total sulphur. Note that the spread between motor and research method octane ratings is 6 points or approximately one-half that obtained by catalytic cracking as previously mentioned.

Fig. 5 shows the effect of varying the severity of the reforming conditions on the yields and octane number of the gasoline produced from this naphtha.

● **U.O.P. catalytic polymerization.** The U.O.P. catalytic polymerization process is one of the first of the many types of catalytic processes now being employed in the refining industry. The propylene and butylenes produced in fluid catalytic cracking, thermal cracking, and thermal reforming, which might otherwise be burned as fuel gas or sold as LPG, can be converted to high octane number liquid polymer and thus increase the overall motor fuel yield and octane number.

The propylene and butylenes can be polymerized either separately or together, depending upon the type of product desired. When the butylenes are polymerized selectively in the absence of other olefins the product can be hydrogenated to produce a 90-95 motor method octane number saturated liquid suitable for use as a component of high grade aviation gasoline.

Table 13 lists the yields of non-selective polymer that can be obtained by polymerizing the propylene and butylenes produced in the fluid catalytic cracking, thermal cracking, and thermal reforming operations described in Tables 7-12. These yields are based on a recovery of 75 per cent of the propylene and 95 per cent of the butylenes in a gas concentration unit. When using the re-

TABLE 9. U.O.P. two-coil thermal cracking high and low sulphur reduced crudes.

Properties of charge stocks and yields

Properties of charge stocks	Temblador, Venezuela,	Sanandita, Bolivia
Volume per cent of crude	70.0*	25.6
Gravity, °API	16.5	24.6
Specific gravity at 60 F	0.9561	0.9065
Sulphur, wt per cent	1.16	0.13
Cold test, F	15	90
Universal viscosity at 210 F, sec	110	61
Salt, lb/1000 bbl	12	None
Characterization factor	11.53	12.04
Yields, per cent of cracking unit charge		
Ethane and lighter gases, cu ft/bbl charge	160	186
Propylene, liquid volume per cent	2.2	2.7
Propane, liquid volume per cent	4.7	3.3
Isobutylene, liquid volume per cent	0.7	0.7
N-butylenes, liquid volume per cent	1.2	2.9
Isobutane, liquid volume per cent	0.8	0.8
N-butane, liquid volume per cent	1.5	2.2
400 F endpoint gasoline, volume per cent		
Debutanized basis	28.8	48.2
10 lb RVP basis	31.3	52.4
Residuum	65.5	40.2

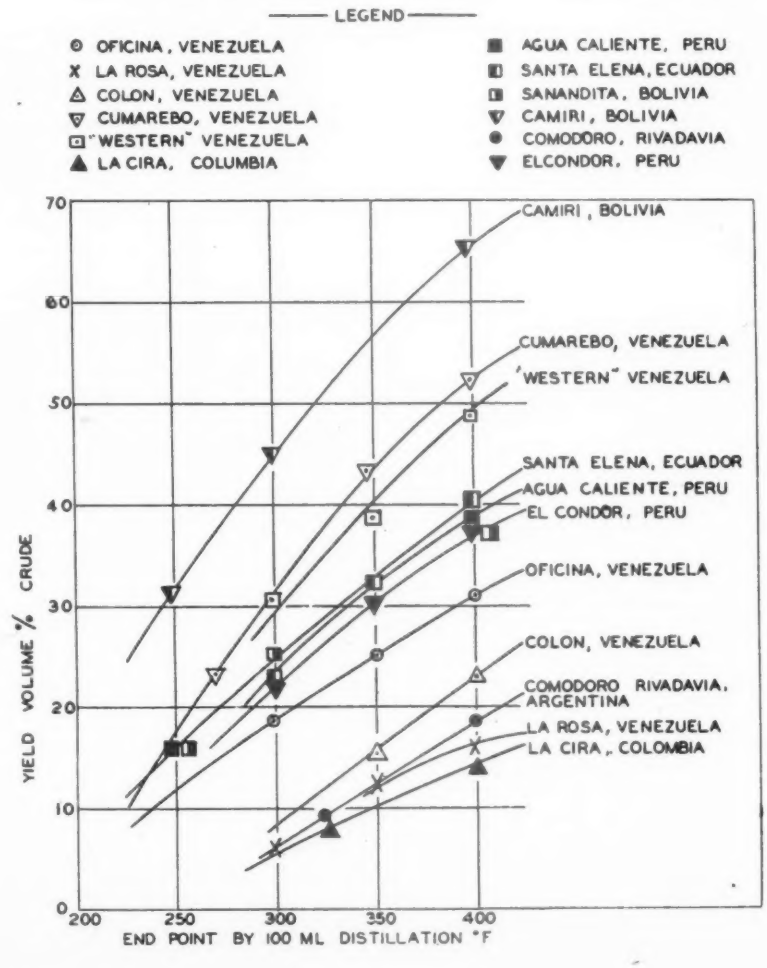
*Obtained in commercial distillation equipment.

TABLE 10. U.O.P. two-coil thermal cracking high and low sulphur reduced crudes.

Properties of products

Source of charge stock	Temblador, Venezuela	Sanandita, Bolivia
Properties of products		
Composition of ethane and lighter gases, mol per cent		
Hydrogen sulphide	4.4	Trace
Hydrogen	9.5	8.6
Methane	58.2	44.6
Ethylene	6.3	12.4
Ethane	21.6	34.4
Total	100.0	100.0
10-lb RVP gasoline (untreated)		
Gravity, °API	57.0	61.7
Specific gravity at 60 F	0.7507	0.7324
Mercaptan sulphur, wt per cent	0.11	0.005
Total sulphur, wt per cent	0.37	0.01
Reid vapor pressure, lb	10.4	9.5
Octane number F-2 Motor Method	74	65
100 ml distillation		
Initial boiling point, F	91	95
10 per cent	141	137
50 per cent	260	249
90 per cent	361	354
Endpoint, F	400	398
Residuum		
Gravity, °API	9.3	7.4
Specific gravity at 60 F	1.0049	1.0187
B. S. & W., per cent	0.4	1.4
Furol viscosity at 122 F, sec	224	303
Cold test, F	25	55
Flash point, Pensky Martens, F	235	200

FIG. 3. End point of straight run gasoline versus yield on crude.



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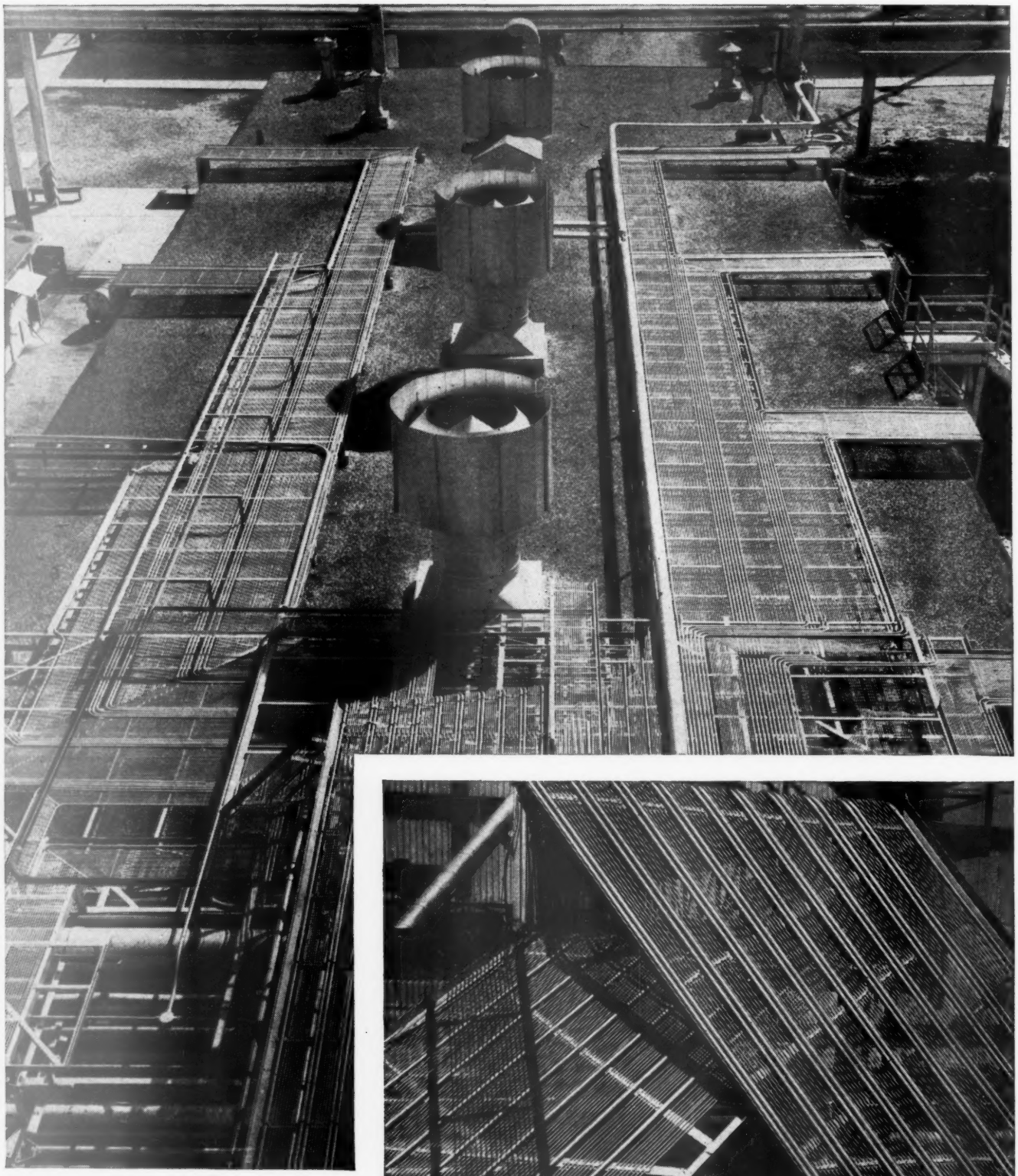

(Right) Network of pneumatic transmission lines leading from processing equipment onto control room roof (above) from which they "peel off" to respective sections of control panels below (opposite page).

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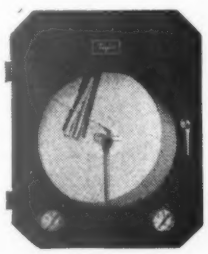

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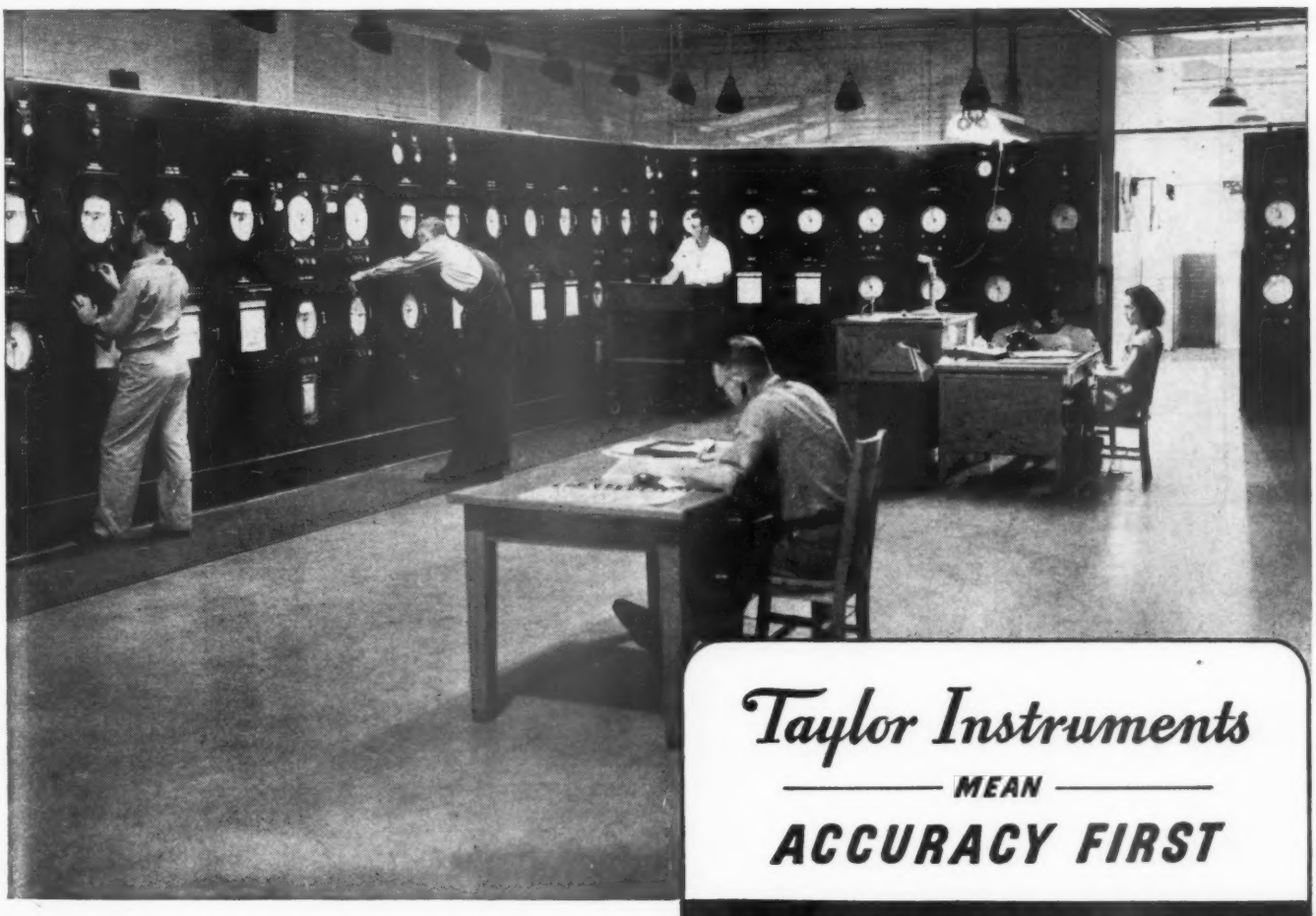

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actor type of polymerization unit it is possible to realize a conversion of 90 per cent of both the propylene and the butylenes to polymer gasoline.

The overall polymer yields given in Table 13 are, of course, dependent upon the quantity of olefins produced in the cracking or reforming operation and the olefin yields in turn depend upon the type of charging stock and operating conditions employed in the cracking or reforming steps. It is interesting to note that in all three of the fluid catalytic cracking tests there is an excess of butanes produced over that required for pressuring the cracked gasoline and the propylene-butylene polymer to 10-lb RVP. There was a slight deficiency of butanes when producing 3-4 per cent polymer from the gases formed in thermal cracking. In the thermal reforming test it would be necessary to use outside butanes for vapor pressure amounting to 3.5 per cent of the reforming unit charging stock when producing 7.3 per cent of 10-lb RVP polymer from the propylenes and butylenes.

The properties of a typical non-selective polymer are also given in Table 13. The unsaturated character of this material is illustrated by its high research method octane ratings and the bromine number.

● **U.O.P. paraffin alkylation.** As previously mentioned, extensive use was made of the U.O.P. alkylation process during the war for the production of aviation gasoline components. In this process isobutane is normally alkylated with propylene, butylenes, or amylenes. Either sulphuric acid or hydrofloric acid may be used as the catalyst. The alkylate produced is a mixture of saturated, stable, liquid, isoparaffinic hydrocarbons boiling in the gasoline range and having a motor method octane rating of 88-95 depending upon the conditions of operation and the quality of the charging stock.

The alkylate produced may be used either as motor fuel or aviation gasoline. At present it would appear that the process will have a greater application for the manufacture of aviation gasoline than for motor fuel. The alkylation process is best suited to operate in conjunction with a catalytic cracking unit, for a greater yield of isobutane is produced in fluid catalytic cracking than in thermal cracking or reforming.

The yields and properties of alkylate given in Table 14 are based on the alkylation of the recoverable isobutane with butylenes in each case to produce a depentanized 350 F endpoint alkylate. A normal recovery of 95 per cent of the C_4 hydrocarbons has been assumed in these calculations. The yield of depentanized butylene alkylate amounts to approximately 1.6 volume per volume of butylene converted and for each volume of alkylate produced about 1.25 volumes of isobutane are required. The yields shown in Table 14 are all based on the charge to the catalytic cracking unit and have been calculated for two cases:

Case I. Assuming that no outside isobutane is available and that the n-butane available is not isomerized.

Case II. Assuming that sufficient outside isobutane is available to alkylate all the butylenes. In this case the n-butane available is also isomerized for use in the alkylation step.

It is apparent that the maximum alkylate yields are obtained in Case II, but there is a deficiency of isobutane in all the tests. In the operation of the catalytic cracking unit specifically for the production of aviation gasoline it is possible to adjust the cracking conditions to produce a balanced alkylation unit feed stock so that there will be no excess or

FIG. 4. Effect of residuum quality on yields. UOP two-coil cracking Sanandita, Bolivia, reduced crude.

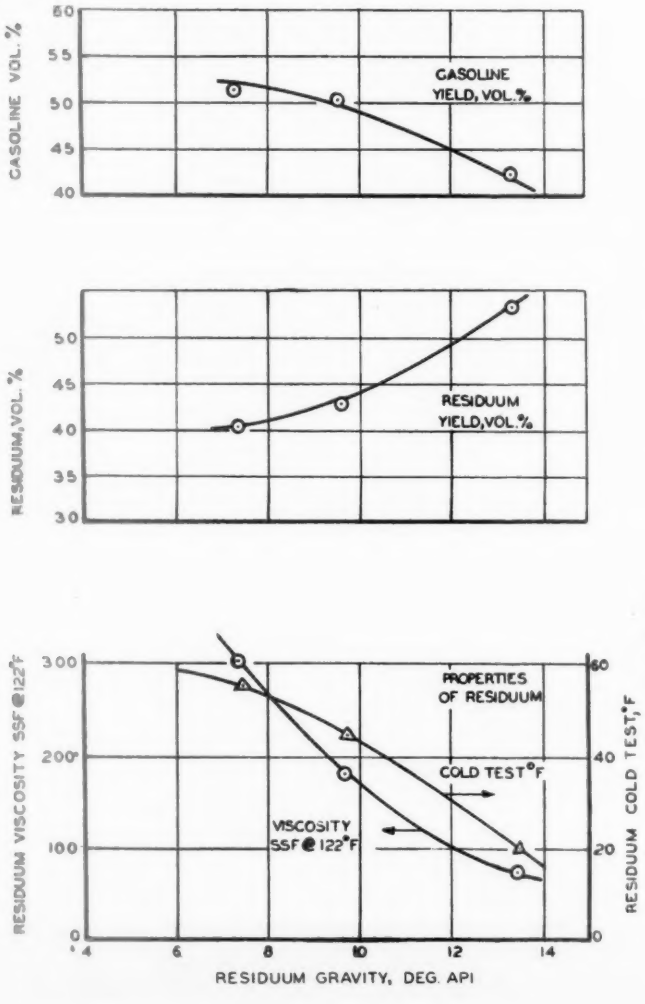
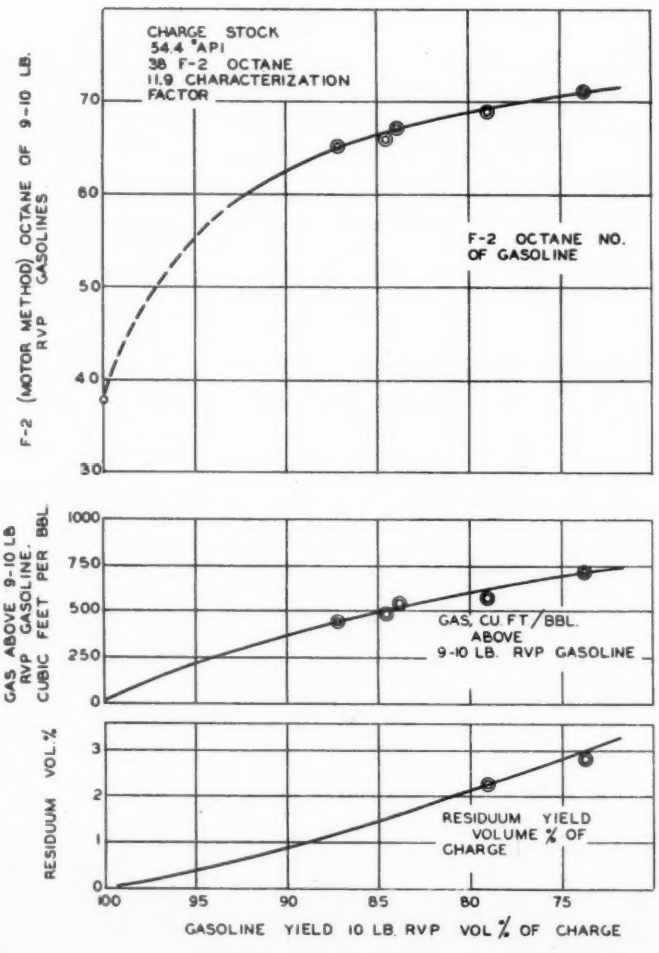


FIG. 5. UOP thermal reforming Argentina straight-run Naphtha.


CHARGE STOCK
54.4 °API
38 F-2 OCTANE
11.9 CHARACTERIZATION FACTOR
F-2 (MOTOR METHOD) OCTANE OF 9-10 LB. RVP GASOLINES
F-2 OCTANE NO. OF GASOLINE
GAS ABOVE 9-10 LB RVP GASOLINE: CUBIC FEET PER BBL.
GAS, CU. FT/BBL. ABOVE 9-10 LB. RVP GASOLINE
RESIDUUM VOL. %
RESIDUUM YIELD VOLUME % OF CHARGE
GASOLINE YIELD 10 LB. RVP VOL % OF CHARGE

deficiency of butylenes or isobutane.

As shown at the bottom of Table 14, the butylene alkylate has an unleaded motor method octane rating of 93.2. The F-3 and F-4 aviation gasoline octane determinations were each made with the addition of 4.0 cc of tetraethyl lead per gallon of alkylate. The F-3, or lean mixture rating, is indicative of the performance of the fuel under airplane cruising conditions and is equivalent to isooctane plus 1.2 cc tetraethyl lead per gallon. The F-4, or rich mixture rating, predicts the performance of the fuel under take-off conditions and is equivalent to the reference fuel S plus 2.9 cc of tetraethyl lead per gallon.

● **Treating and inhibiting.** Dyed rather than water-white gasolines are marketed almost exclusively in the United States, with a resultant saving in treating costs and a reduction of gasoline losses. If it were necessary to produce a water-white finished gasoline in all cases, much more extensive treating facilities would be required in the average refinery. With the use of dyes and the addition of inhibitors to motor fuels to prevent deterioration in storage, the problem of treating gasolines is primarily one of sulphur reductions to meet odor or arbitrary sulphur specifications.

The U. S. Government specifications for the total sulphur content of motor fuel is now 0.25 per cent maximum, which is followed by most states. One pipe-line company specifies 0.1 per cent maximum sulphur on the gasoline transported in its lines. It has been firmly demonstrated, however, that motors are not harmed by operation on ordinary fuels containing as much as 0.25 per cent total sulphur and in some areas motor fuel containing 0.4 per cent total sulphur or higher have been marketed without difficulty.

Fortunately a large number of the South American crudes are quite low in sulphur content as shown by the data given in Tables 1 and 2. With an increasing demand for petroleum and its products, however, the trend may be toward the use of crudes with higher sulphur contents. If it becomes necessary for South American refiners to process a greater proportion of these crudes to produce motor fuels of unduly low sulphur content, the treating of the gasoline will be costly.

Table 15 has been prepared to illustrate, largely with estimated results based on experience with the treatment of other gasolines, the treatment steps that would be recommended to produce finished gasolines from the cracked and reformed products described in earlier sections of this article. The following paragraphs discuss the treatment of the gasolines produced in these operations.

TABLE 11. U.O.P. thermal reforming Argentine straight run naphtha.

Properties of charge stock and yields

Properties of charge stock	
Gravity, °API	54.4
Specific gravity at 60 F	0.7612
Sulphur, wt per cent	0.03
F-2 octane number (Motor Method)	38
Characterization factor	11.95
100 ml distillation	
Initial boiling point, F	248
10 per cent	265
30 per cent	275
50 per cent	285
70 per cent	297
90 per cent	327
Endpoint, F	386
Yields, per cent of naphtha charge*	
Ethane and lighter hydrocarbons, cu ft/bbl	240
Propylene, liquid volume per cent	5.1
Propane, liquid volume per cent	5.8
Butylenes, liquid volume per cent	5.7
Isobutane, liquid volume per cent	1.3
N-butane, liquid volume per cent	2.1
400 F endpoint gasoline, volume per cent	
Debutanized basis	78.5
10-lb Reid vapor pressure basis	85.0
Residuum, volume per cent	1.5

*The proportion of light gases produced was estimated from correlations.

TABLE 12. U.O.P. thermal reforming Argentine straight run naphtha.

Properties of products

Composition of ethane and lighter hydrocarbons*, mol per cent	
Hydrogen	6
Methane	42
Ethylene	12
Ethane	40
Total	100
Properties of untreated gasoline	
Gravity, °API	55.5
Specific gravity at 60 F	0.7567
Total sulphur, wt per cent	0.01
Mercaptan sulphur, wt per cent	0.0001
Reid vapor pressure, lb	10.7
F-2 octane number (Motor Method)	66
F-1 octane number (Research Method)	72
100 ml distillation	
Initial boiling point, F	90
5 per cent	139
10 per cent	165
20 per cent	216
50 per cent	273
90 per cent	356
Endpoint, F	403
Per cent over	95.0
Per cent bottoms	1.0
Per cent loss	4.0

*Estimated from correlations.

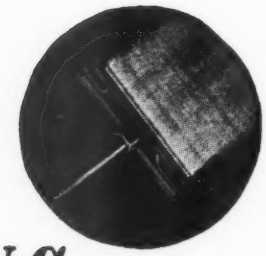
TABLE 13. Non-selective polymerization of gases from fluid catalytic cracking, thermal cracking, and thermal reforming.

Process	Fluid catalytic cracking			Thermal cracking		Thermal reforming
Charge stock to cracking or reforming	Lagunillas gas oil	Mid-Cont. gas oil	West Texas gas oil	Temblador reduced crude	Sanandita reduced crude	Argentina naphtha
Reference: Table nos	7–8	7–8	7–8	9–10	9–10	11–12
Yields, volume per cent of charge stock to cracking or reforming unit						
Propylenes before polymerization	5.5	5.0	4.4	2.2	2.7	5.1
Butylenes before polymerization	4.3	6.9	5.7	1.9	3.6	5.7
Polymer						
Debutanized	5.7	7.2	6.1	2.4	3.8	6.5
10-lb RVP	6.4	8.1	6.9	2.7	4.3	7.3
Excess butanes above 10-lb RVP	+1.7	+1.1	+0.1	−0.4	−1.4	−3.5
polymer						
Properties of non-selective polymer						
Gravity, °API			64.0			
Specific gravity at 60 F			0.7238			
Octane numbers						
F-2 (Motor Method) clear			82.5			
F-2+3cc TEL per gal			85			
F-1 (Research Method) clear			97			
F-1+3cc TEL per gal			100			
Reid vapor pressure, lb			10			
Bromine number			130–150			
100 ml distillation						
Initial boiling point, F			90			
10 per cent			155			
50 per cent			230			
70 per cent			260			
90 per cent			355			
Endpoint, F			400			

TABLE 14. U.O.P. alkylation of isobutane with butylenes from fluid catalytic cracking.

Charge stock to cracking	Lagunillas gas oil	Mid-Continent gas oil	West Texas gas oil
Reference: Table nos	7–8	7–8	7–8
Yields, volume per cent of charge stock to cracking unit			
Butylenes	4.3	6.9	5.7
Isobutane	3.6	4.2	3.0
n-butane	1.0	2.3	1.3
Case I—Isobutane limiting, no isomerization			
Depent. 350 F endpoint alkylate	4.3	5.0	3.6
Excess butylenes after alkylation	1.4	3.5	3.1
Case II—Alkylation of all butylenes, including isomerization			
Depent. 350 endpoint alkylate	6.6	10.6	8.6
Isobutane deficiency	1.0	2.5	2.9
Properties of butylene alkylate*			
Gravity, °API	70.2		
Specific gravity at 60 F	0.7015		
Reid vapor pressure, lb	2.8		
Octane ratings			
F-2 (Motor Method)	93.2		
F-3 (1-C Method + 4cc TEL/gal	iso-octane + 1.22cc TEL/gal		
F-4 (3-C Method + 4cc TEL/gal	8 + 2.9cc TEL/gal		
100 ml distillation			
Initial boiling point, F	140		
10 per cent	191		
30 per cent	211		
50 per cent	219		
70 per cent	225		
90 per cent	242		
Endpoint, F	350		

*From butylenes produced by catalytic cracking.



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PUROX, PREST-O-WELD, HELIARC,
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CUTTING, AND HEATING

the way for the "Big Blow"

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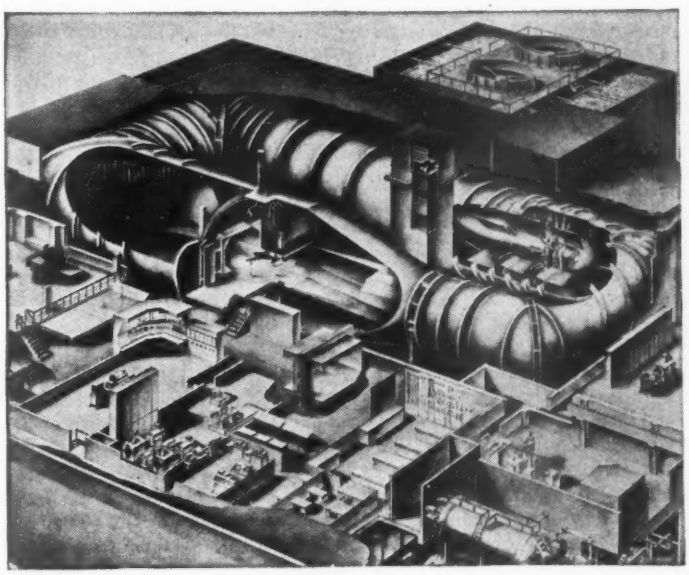

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TABLE 15. Treatment of gasolines from fluid catalytic cracking, thermal cracking, and thermal reforming.

Gasoline from	Fluid catalytic cracking		Thermal cracking				Thermal cracking		Thermal reforming	
Charging stock to cracking or reforming	Lagunillas gas oil		Temblador reduced crude				Sanandita reduced crude		Argentina straight run naphtha	
Reference: Table nos:	7-8		9-10				9-10		11-12	
Treatment of gasoline	None	30 Be batch* caustic wash	None	Unisol*	Split caustic acid and doctor sweetening		None	30 Be batch* caustic wash	None	Dilute batch* caustic wash
Sulphuric acid, lb/bbl					6	10				
Treating losses, per cent of gasoline										
Acid solution loss					3.0	5.1				
Polymerization loss					1.7	2.4				
Distillation loss					2.8					
Total loss					7.5	9.9				
Properties of charge and products										
Gravity, °API	53.4		57.0		56.6	56.7	61.7		55.5	
Specific gravity at 60 F	0.7653		0.7507		0.7523	0.7519	0.7324		0.7567	
100 ml distillation										
Initial boiling point, F	125		91		103	106	95		90	
10 per cent	155		141		155	158	137		165	
50 per cent	250		260		259	259	249		273	
90 per cent	368		361		355	347	354		356	
Endpoint, F	405		400		396	398	398		403	
Reid vapor pressure, lb										
Octane numbers										
F-2 (Motor Method) clear	80.6	80.6	74†	74.5	73	73	65	65	66	66
F-2 + 3.0cc TEL/gal	84.2	84.2	(80)	82	(81.5)	(81.5)				
Doctor test	Positive	Slightly sour	Positive	Positive‡	Negative	Negative	Positive	Positive	Slightly sour	Slightly‡ sour
Mercaptan sulphur, per cent	0.002	.....	0.11	0.0005‡	0.02†	0.005†	0.005	0.001	....	....
Total sulphur, per cent	0.19	0.19	0.37	0.26	0.19	0.13	0.01	0.01	0.01	0.01
Copper dish gum, Mg/100 ml										
Without inhibitor	125	....	382	....	21	15	117	75	173	
With 0.005 per cent U.O.P. no 4 inhibitor	....	Below 25	....	Below 25	5	10	....	Below 25	11	
Oxygen bomb induction period, min										
With inhibitor	395	....	215	100	165	120	610	300	100	
With 0.005 per cent U.O.P. no. 4 inhibitor	....	400	....	Above 300	480	460	....	300	100	

*Data estimated from correlations.
†Before final caustic wash and doctor sweetening. Values may be slightly low due to oxidation in handling laboratory samples.
‡Usually sweet after 1-2 days storage.

● **Fluid catalytically cracked gasoline.** Untreated catalytically cracked gasolines are usually characterized by long induction periods and relatively high copper dish gums, as indicated in the first column of Table 15. These properties are generally attributed to the presence of cresols in the raw gasoline. The addition of synthetic inhibitor to the gasoline will not reduce the gum in most cases, and it is only after the cresols have been removed and a synthetic inhibitor added that the gum test is normally satisfactory.

A relatively strong 30-35 Bé caustic wash is used to remove cresols prior to inhibiting. It is estimated that if the Lagunillas catalytically cracked gasoline described in Table 15 were caustic washed and inhibited with 0.005 per cent U.O.P. No. 4 inhibitor, a product of satisfactory storage stability having a copper dish gum lower than 25 Mgs and an induction period of about 400 minutes would be obtained. Caustic washing does not usually completely sweeten the gasoline, but in many cases the product is sweet after a few days' storage, and, in any case, will be of good odor. Either doctor or copper sweetening could, of course, be employed to obtain a sweet product before storage.

● **Thermally cracked gasoline.** The cracked gasoline produced from the Temblador reduced crude, as described in Tables 9 and 10, contained 0.11 per cent mercaptan sulphur and 0.37 per cent total sulphur. This gasoline was acid treated in two separate treats using both 6 and 10 lb of acid per barrel of gasoline in order to determine the amount of acid required for sulphur reduction. In view of the rather high mercaptan content of the gasoline a "split" caustic type of treatment was used. This treatment consists of washing with caustic before acid treatment and also before doctor sweetening in order to remove the lighter mercaptans by solution rather than converting these mercaptans to other sulphur compounds, which might remain in the gasoline. The data show that a loss of nearly 10 per cent of the gasoline was incurred while producing a product containing 0.13 per cent total sulphur in the 10-lb acid treat.

If total sulphur specifications will permit, the Unisol mercaptan extraction process is a much simpler and more economical method of producing a finished fuel from the Temblador cracked gasoline. In this process the mercaptans are extracted with a caustic methanol solution continuously and removed from the system. As shown in Table 15, it is estimated that the Unisol treated Temblador gasoline would still be very slightly sour to the doctor test but would contain no trace of odor. Normally this degree of sulphur reduction by the removal of mercaptans from this type of gasoline will result in an improvement of approximately two points in the leaded motor method octane rating.

The thermally cracked gasoline produced from the low sulphur Sanandita reduced crude would merely be batch caustic washed, sweetened, and inhibited to produce a finished product. A relatively strong caustic wash (30-35 Bé) would be used to remove cresols, the presence of which are indicated by the high induction period of the raw gasoline.

● **Thermally reformed gasoline.** The treatment of the reformed Argentine gasoline listed in Table 15 is simple because it is low in mercaptan and total sulphur content and has a satisfactory response to inhibitor before treatment. A dilute batch caustic wash followed by inhibiting is all that should be required since it would be expected that the small amount of mercaptan present would be oxidized in storage.

The preceding discussion of treating methods has been based on the assumption that dyed gasolines can be marketed. If it is necessary to produce a water-white fuel, either clay treating or acid treating usually must be employed. The choice of the type of clay treating or the decision to use acid treating depends upon the type of gasoline to be treated and many other factors. For example, since the catalytic cracking unit fractionator operates at relatively low pressure it is not feasible to consider vapor phase clay treating the gasoline from this process. In order to produce a water-white catalytically cracked gasoline, low temperature liquid phase clay treating would probably be used. Vapor phase clay treating installed in the fractionator vapor line on thermal cracking and reforming units is a satisfactory method of improving color. A clay life of 1000 to 3000 bbl of gasoline per ton of clay usually can be obtained in this operation. The treated product requires rerunning in order to remove the polymers formed, which normally amount to 3 to 4 per cent of the gasoline charge. ★ ★ ★

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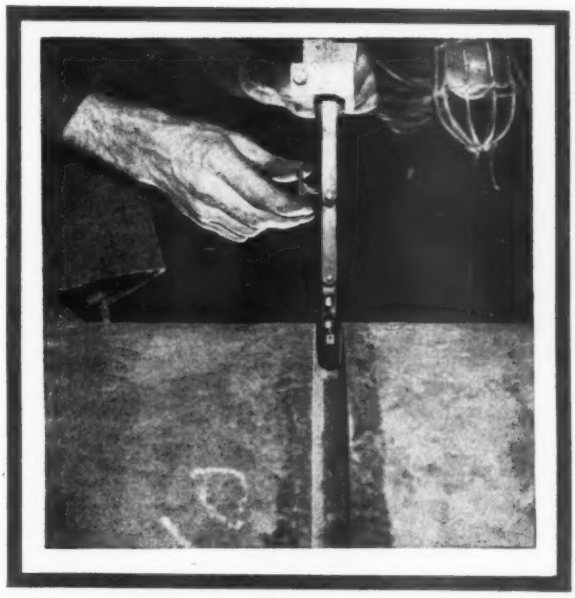
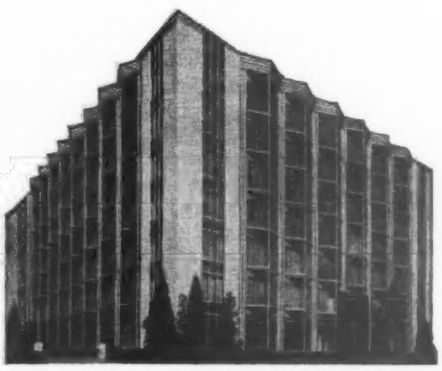
1—It reduced man-hours of welding time 50% to 80%.
2—The process was applicable to high tensile steels.
3—It materially reduced the inherent risk in welding at high preheats.



Considerable practical experience with this technique, augmented by the development of specially designed equipment, constitutes a distinct advancement in the art of welding, offering new advantages to designers of welded structures.



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P 720.1

Hydrocarbon absorption and fractionation process design methods

Part 1. Introduction and Summary

By **WAYNE C. EDMISTER,**
Hydrocarbon Research, Inc.

INTRODUCTION

The preparation of this series of articles began several years ago in Chicago when the author was teaching part time at Illinois Institute of Technology while working as a process design engineer for Standard Oil Company (Indiana) at Whiting. The war and an interlude at Washington in synthetic rubber work interrupted the completion of this treatise. Recently, the author revived his activities in this field by publishing a multicomponent fractionation design method.

THE PETROLEUM ENGINEER *is pleased to bring its readers this series, which will include a review and comparison of the many process design methods that have been proposed during recent years and also several new and original developments of the author.*

☆ ☆ ☆

THE separation of hydrocarbon mixtures into various components and fractions for further processing and/or marketing is of paramount importance in the natural gasoline, petroleum refining, and petro-chemical industries. It has been said that separation processes are the backbone of the hydrocarbon industries. Separation equipment represents a substantial fraction of the total capital cost of hydrocarbon processing equipment. This fraction has been estimated at 30 to 45 per cent, which is higher than any other class of equipment. Separation efficiency is also an important fraction in the plant operating costs of any hydrocarbon processing system, because efficient separation means lower losses, less recycle, purer products, etc. For these reasons the subject of hydrocarbon separation can hardly receive too much attention.

EXCLUSIVE

During the past decade, the importance of hydrocarbon separation operations has been overshadowed by a widespread and very active interest in the development, design, and operation of new catalytic conversion processes for the manufacture and refining of improved hydrocarbon products from petroleum. These hydrocarbons include: Aviation gasoline; synthetic rubber, and other products essential for war and peace. Now there is a great deal of interest in the synthesis of hydrocarbons and other products from natural gas and coal, as well as from petroleum refinery by-products. In his eagerness to push ahead, the hydrocarbon process engineer appears to be neglecting some of the most fundamental processes such as absorption and fractionation, that are employed in all hydrocarbon processing schemes.

In the commercial application of the new catalytic conversion and synthesis processes, that have been and still are in the news, more efficient hydrocarbon separations are often required. The manufacture of alkylate, toluene, butadiene, and other valuable hydrocarbon products from petroleum involves separations that are more sharply cut than the separations in the conventional distillation of crude oil. This increase in fractionation requirements usually results in more elaborate and extensive equipment, which is more complex to design and operate.

Because of the complex composition of petroleum, hydrocarbon separation has always been and will continue to be an essential part of all present and future petroleum refining processes, both thermal and catalytic. Although hydrocarbons may be separated by many different types of operations (including adsorption, absorption, azeotropic distillation, extractive distillation, solvent extraction, fractional distillation, filtration, precipitation, centrifugalization, etc.) the most widely used process is fractional distillation. Absorption, followed by steam stripping of the enriched oil, is also widely used to recover valuable hydrocarbons from wet refinery and natural gases. In most commercial plants both fractionation and absorption are employed.

SCOPE

The purpose of this series of articles is to present the basic theory and the development and application of process design methods for absorption-stripping and fractional distillation. These separation processes are examples of diffusional operations that function through interphase transfer of components between the liquid and vapor. They are the most widely used processes for separating hydrocarbons. The process design of absorption and fractionation operations is the scope of this treatise.

Although plant operation is not within the scope of this series, many of the process design methods discussed are useful in analyzing performance data and making recommendations for changes in operating conditions. Operating revisions are frequently necessary because of new production requirements or product specifications, etc., so some attention will be given to the methods used in analyzing plant performance. Instrumentation of absorption and fractionation equipment is likewise outside the scope of this series. In general the discussion will be limited to the theoretical and empirical process design calculation methods for the bubble plate column and its auxiliaries, including the integration of these facilities into complete plants.

In this treatment of the process engineering of hydrocarbon absorption and fractionation, the objectives are: (a) to summarize the basic concepts and fundamentals; (b) to review some of the important contributions that have been made during the recent years in this field; (c) to present new and improved process design methods, including the complete developments, charts and examples; (d) to cover empirical as well as theoretical design methods; (e) to discuss plate and thermodynamic efficiencies, including correlations and methods of computing and applying these efficiencies in process design calculations; (f) to outline methods of sizing, selecting, and integrating bubble tower and auxiliary equipment; and (g) to emphasize the need for consistent data and methods for process design calculations, which require coordinated development studies and standardized thermodynamic data on the hydrocarbons.

All processes and design methods known cannot be included in this treatise because of a lack of space. The discussions will therefore be limited to those considered most important or most illustrative. Many of the design methods presented here are of recent development and have not been proved by years of long use. Some of the methods presented have been developed or modified by the author in preparing these articles. Some are not completed but are included to illustrate an important concept or technique. Some design methods that are not recommended by this author for solving design problems will be presented anyway in order to illustrate an important point and/or add to the background of the study. The presentation of the process design calculation methods will be preceded by a brief discussion of the basic concepts involved. In preparing these articles the technical literature was referred to so frequently that it is not practical to give all references. However, the most outstanding articles and books referred to will be listed. A few general references are included at the end of this article. With each succeeding article specific references will be given.

Refinery Equipment and Supplies
PIPE—(Con'd.)
—Copper Bearing
—Corrosion Resisting
—Flanged
—Lapweld
—Line
—Steel
—Steel Seamless
—Welded
—Wrought Iron
PIPING—Condenser
—Copper
PLUG COCKS—Acid
PLUGS—Fusible
PLUMB BOBS—for Tapes
PUMPS—Ammonia
—Asphalt
—Boilerfeed
—Brine
—Butadiene, Butane, Propane
—Centrifugal
—Duplex
—Hot Oil
—Hydraulic
—Pipe-Line
—Plunger
—Quintuplex
—Rotary
—Simplex
—Slurry or Sludge
—Tar
—Triplex
—Vacuum
—Vertical
PUNCHES AND CHISELS
REAMERS—Pipe
RECORDERS—Pressure
—Temperature
—Wet and Dry Bulb
REGULATORS—Back Pressure
—Balanced Valve
—Gas
—Pressure
—Pressure Reducing
—Temperature
RINGS—Chill
—Welding
SADDLES—Welding Pipe
STOCKS AND DIES
STUDS—Alloy
TACHOMETERS
TAPES—Measuring
TEES—Welding, Pipe
TESTERS—Gauge
THERMOMETERS—Dial
—Etched Stem
—Laboratory
—Gas Filled
—Indicating
—Industrial
—Metal Armors
—Recording
—Red Reading Mercury
—Vapor Tension
—Wet and Dry Bulb
THREADOLETS
TONGS—Chain, Pipe
—Pipe
TUBES—Alloy Steel
—Boiler
—Brass and Copper
—Condenser
—Corrosion Resisting
—Cracking Still
—Heat Exchanger
—Still
TUBING—Centrifugally Cast
—Steel
UNIONS—Flange
—Forged Steel
—Screwed
—Socket Weld
VALVE CHAIN WHEELS
VALVES—Acid Resisting
—Air
—Ammonia
—Angle
—Bail Check for Gauges
VALVES—(Con'd.)
—Bell End
—Bleeder Line
—Blow-Off
—Bronze
—Butterfly
—Cast Steel
—Check
—Check, Rubber Seal
—Diaphragm
—Double Disc
—Drain
—Foot
—Forged Steel
—Four-Way
—Gauge
—Gauge Glass
—Globe
—Hard Faced
—High Pressure
—Hydraulic
—Iron
—Lift-Type Plug
—Lubricated Plug
—Manifold
—Motor-Operated
—Multiport
—Needle
—Non-Return
—Plug
—Quick Opening and Closing
—Relief
—Steam Jacketed
—Switch
—Three-Way
—Water Column
VALVE-LOCKING DEVICES
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RESUME OF FUNDAMENTALS

Both absorption and fractionation function through a concentration difference between enriched and depleted streams and the multiplication of this difference by countercurrent contacting of the vapor and liquid in packed or bubble plate columns. The concentration differences at each point or stage of the process are caused by interphase transfer of material, from vapor to liquid and vice versa, by either or both of two mechanisms, namely, diffusion and vaporization-condensation.

Absorption and stripping are diffusional processes while fractionation is a vaporizational process. There is not a clearcut sharply drawn distinction between absorption and fractionation because some diffusion occurs in fractionation and also some vaporization takes place in absorption. The same properties of the hydrocarbons are used to express equilibrium in both cases and this makes it hard to distinguish between the two mechanisms. However, the predominating mechanism of absorption is diffusion, while vaporization and condensation are the predominating mechanisms in fractionation.

Thus, the study of hydrocarbon absorption and fractionation is concerned with two basic mechanisms, diffusion and vaporization. Both mechanisms of interphase material transfer depend upon a driving force to make the transfer. For both absorption and fractionation the driving forces for this interphase material transfer are concentration differences. For absorption, the diffusional driving force is the difference in the concentration of the component in the gas and the solvent lean oil. For fractionation, the vaporization driving force is the difference between the actual composition of the vapor and liquid phases and the equilibrium compositions of the phases.

The phase equilibrium concept is usually employed in both absorption and fractionation process design calculations and the approach to or distance from equilibrium conditions included in the plate efficiency. Actually neither process occurs under equilibrium conditions, although the interphase material exchange that takes place in light hydrocarbon fractionation is closer to equilibrium than the mechanism of absorption. The fact that the lean oil is always at a temperature and volatility far below the equilibrium conditions helps to make absorption far removed from equilibrium.

Plate efficiency is an expression of the distance from equilibrium and is defined in terms of equilibrium or theoretical plates in the following two ways: (a) the ratio of actual composition change across a stage to the change that would have occurred had equilibrium been reached, or (b) the ratio of the number of theoretical to the actual number of stages required. The process calculations for both absorption and fractionation would be much more complex without the simplifying theoretical equilibrium plate concept. Phase equilibrium is expressed by vapor and total pressures where ideal gas and ideal solution laws apply and by fugacities of the liquid and vapor where the conditions deviate from ideality. For most hydrocarbon separation calculations it is safe to assume ideal solutions and correct for deviations from ideal gas laws by using fugacity equilibrium constants based on PVT data only. For non-ideal solutions actual experimental data are required on phase behavior.

In addition to the equilibrium phase distribution constant, K, the relative molal quantities of vapor and liquid are used in the process design methods for absorption and fractionation. These variables are combined in the form L/KV, the absorption factor, and KV/L, the stripping factor. These two factors, which are designated A and S, respectively, are used in both absorption and fractionation as a measure of the interphase transfer driving force. These factors were first applied to absorption and stripping and then later to fractionation calculations. The use of the L/KV factor is no more of an approximation for fractionation than it is for absorption. The A and S factors will be used in developing equations for both absorption and fractionation. Thus the mathematical expressions for the hydrocarbon absorption-stripping and fractional distillation processes have these similarities. Hydrocarbon absorption and fractionation calculations are made with the same phase equilibrium data, the same L/KV and KV/L factors, but with different equations. It should be recognized that process design methods based on the use of these A and S factors and the theoretical plate concept are approximations. For that matter so is any plate-to-plate calculation using theoretical plates and phase equilibrium constants. The use of vapor pressure or fugacity equilibrium constants in absorption and fractionation calculations does not mean that an equilibrium distribution of the components is obtained between the vapor and liquid phases. The approach to equilibrium is dependent upon the time and efficiency of contact, and the properties of the fluids.

The operation of hydrocarbon absorption and fractionation processes, like any other process, requires energy in the form of heat or pumping power to carry out the work of separation and supply the differences in the heat contents of the components being separated. Some of this energy is required to maintain the interstage flows of vapor and liquid. The type of energy required to maintain the interstage vapor and liquid flows is different in absorption and fractionation. In fractionation heat supplies most of the energy, while in absorption-stripping the energy is added in the form of pumping and compressing power plus open steam for stripping. The energy required in both of these processes is supplied at a higher level, passes through the process, and is then rejected at a lower level. Thus a portion of all energy supplied is rejected from the process at a low temperature as a natural consequence of doing the work of separation. This energy path is typical of all process and mechanical engines. Efficiency of energy utilization can be improved by lowering the level at which energy is supplied and raising the level at which it is rejected. The quantities of energy supplied and rejected and the temperature levels at which these energy transfers occur together with phase equilibrium and component concentrations determine the thermodynamic efficiency of a separation process.

Thermodynamic properties of hydrocarbons and their mixtures are required in making process design calculations for absorption and fractionation operations. Fundamental data of this kind are particularly important because in addition to applications in the theoretical design calculations they are also used in analyzing plant performance data to develop design tools for plate efficiency and column capacity. There is an urgent need for standardization of hydrocarbon thermodynamic data in order to assure consistency in process design calculations. It should be obvious that plate efficiencies obtained by analyzing plant performance data with one set of phase equilibrium constants cannot be applied accurately with another set of K constants. This is being done every day, however, because of a lack of widely accepted data. The same applies to enthalpy data and also to theoretical plate calculation methods.

Although many absorption and fractionation process design tools are developed by the application of thermodynamics to hydrocarbon properties, thermodynamics has definite limitations, which should be kept in mind while working on any process design problem. Rates of diffusion and approach to equilibrium cannot be computed by thermo-

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Edmister has spent considerable time in Spain, Portugal, Canary Islands, and Brazil working on various engineering problems. He lives at 7 Gilmore Court, Scarsdale, New York.

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dynamics any more than rates of heat transfer or fluid flow can be. Fugacities and enthalpies are used to make equilibrium and heat balance calculations but the calculation of rates involves using driving forces and resistances. Fugacity phase equilibrium constants are used to estimate the composition of equilibrium vapor and liquid but not the rate of approach to equilibrium or the contact time required. In the preceding discussion, the driving force for interphase transfer of components was discussed in terms of distance from equilibrium. In addition to driving force, the resistance must also be known before the rate of transfer can be calculated. Simplifications are used to avoid these complex and difficult component rate transfer calculations. Multicomponent absorption and fractionation design is complex enough as it is without making diffusion and rate calculations at each plate.

An interesting comparison of absorption-stripping and fractionation appears in the difference in their degrees of reversibility. Fractional distillation is a potentially reversible process, whereas absorption-stripping is only a partially reversible process. In other words, the work of separating hydrocarbons via fractionation can theoretically be reduced to the minimum required by thermodynamics, whereas this is not possible in absorption-stripping. The minimum thermodynamic work required to separate hydrocarbons is a function of the composition of the charge and the products only and independent of the separation process being used. Absorption-stripping is only partially reversible because the lean oil is not in equilibrium with the exit gas, the oil having been stripped to a very low volatility to avoid solvent losses. As practiced, absorption is not reversible and the composition of the exit gas and the pressure are not sufficient to fix the temperature.

EFFICIENCIES

In all engineering design calculations, efficiencies are involved. For hydrocarbon separations, the efficiencies of interest are the "plate" and "thermodynamic" efficiences. Plate efficiency pertains to the vapor-liquid contacting. Thermodynamic efficiency pertains to the utilization of energy. In addition to these, there is the "separation" or "recovery" efficiency of the process. Before discussing process design procedure, the following comments are offered on efficiencies:

In most all industrial hydrocarbon absorption and fractionation operations the bubble plate column is employed as the means of bringing vapors and liquids into contact. The bubble plate column is a series of contact stages with countercurrent flow of vapor and liquid between stages but not within each individual stage. The bubble plate is a stage wherein equilibrium is approached. This is different than the situation existing in a packed column where there is true countercurrent flow between the vapor and the liquid, and differential interphase transfer of components. The theoretical equations and calculation methods used for differential and for stage processes are different, although stage calculation methods are frequently used for packed columns with empirical determined HETP (height equivalent to theoretical plate).

In both differential and stage processes, the vapor and liquid flow in opposite directions in the column, the vapor going up and the liquid going down. The purpose of the packing and the bubble plate is to bring about effective contact between the two phases to permit the transfer of heat and material. The contacting efficiency is a function of the mechanical design of the contacting device, the vapor and liquid flow rates, and the properties of the fluid. For capacity reasons bubble plates are used in hydrocarbon industries, although the packing usually gives more efficient contacting. The lower boiling and less viscous hydrocarbons offer less resistance to interphase transfer of components and accordingly give a higher plate efficiency. With reference to the plate efficiency, it is common practice to use overall plate efficiencies and apply them to the computed number of theoretical plates in order to determine the number of actual plates. This is not strictly correct from a theoretical standpoint, because the efficiency is a measure of approach to equilibrium on each tray and the theoretical plate concept is based on an equilibrium stage. A more correct method of applying plate efficiency is to use local efficiencies and apply these in the theoretical plate and component calculations to determine the number of actual trays correctly, rather than going through the overall plate efficiency stage.

Using the theoretical plate and plate efficiency concepts as discussed above, it is possible to make multicomponent computations for multiple stage absorption and fractionation operations, determining the component distribution and the number of stages required. Such calculations involve simultaneous phase equilibrium and component material balances along with the necessary heat balances to determine the interstage flows. The procedure followed in making these calculations depends to some extent upon the starting point and the desired results. In some cases the problem is to determine the number of plates to yield the desired products and in other cases the problem is the opposite. At best, the design calculations are not perfectly straight forward and require successive approximations usually employing primary and secondary assumptions. In order to make multicomponent fractionation calculations in a reasonable length of time, it is necessary to have shortcut procedures, which include the simultaneous multistage functions covering equilibrium and material balance relationships. In developing and using any shortcut procedure it is necessary to avoid, in so far as possible, making simplifications which introduce major inaccuracies. As indicated above any calculation based on the theoretical plate concept is a simplification so there is no reason to avoid simplifications.

Another efficiency of interest in this treatise of absorption and fractionation, is thermodynamic efficiency, which is a function of the compositions of the products and the feed, the quantities of heat added and removed and the temperature levels at which these heat transfers occur. The thermodynamic efficiency is the ratio of the minimum work to the actual work required to make the separation. The minimum is a function of composition only and independent of the mechanism of separation, whereas the actual work is a function of the system employed to make the separation. In the conventional bubble plate fractionation tower where heat is added at the bottom and removed at the top, the means of supplying and rejecting heat are not as efficient as could theoretically be made. This is because more heat is added at the bottom than is necessary to maintain the required interphase flow. A more efficient way of supplying the heat will be discussed later.

PROCESS DESIGN PROCEDURE

Hydrocarbon absorption and fractionation equipment may be designed by theoretical, empirical or pilot plant methods. The procedure used is, to a certain extent, a function of the kind of stocks involved. For example, it is common practice to use theoretical calculations for light hydrocarbon absorbers and fractionators operating at normal pressures. On the other hand separations involving kerosine and gas oil are usually made by empirical methods which in turn may be based upon pilot plant or commercial plant data or both. In the case of heavy oils such as reduced crudes, lube oils, and asphalts it is usually necessary to do the design by means of pilot plant operating data because theoretical or even empirical methods are frequently unreliable. In this connection it is of interest to recognize the fact that pilot plant investigations of hydrocarbon conversion processes frequently involve the pilot plant preparation of feed stock for reaction studies. During the course of this feed preparation work it is frequently possible to obtain at the same time sufficient data to make designing the commerical separation plant much easier.

The various calculation steps involved in performing the process design of hydrocarbon absorption and fractionation equipment may be grouped into the following three classifications: (1) theoretical plate and component calculations, (2) estimation of the plate efficiency and the actual number of plates, and (3) sizing the column and its plates and auxiliaries for capacity. Each of these may, in turn, be broken down into the individual activities or steps, many of which overlap or, at least, involve using the same fundamental data on the thermodynamic properties of hydrocarbons.

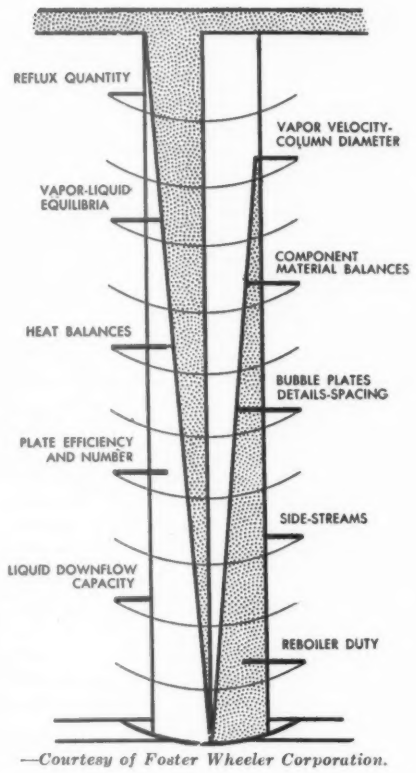
In general, the process design procedure followed in both absorption and fractionation is to make simultaneous phase equilibrium and material balance calculations from stage-to-stage throughout the column. Although this is a com-

plex calculation, it is possible to proceed through the column in this way in a more or less straight-forward fashion. The calculations for fractionation are more straight-forward than the ones for absorption, because in absorption temperature is an additional independent variable, which makes heat balances necessary to determine the temperature changes. Heat balances are also desirable in fractionation calculations but for a different reason. In fractionation the heat balances are required to determine the quantities of vapor and liquid. Knowing the quantities of vapor and liquid, the temperatures are obtained by the simultaneous equilibrium and material balance calculations. For absorption the heat balances are required to determine temperatures rather than the quantities of vapor and liquid.

For most hydrocarbon fractionation operations the molal overflow quantities are substantially constant, which greatly simplifies the process design calculations. For binary systems the simultaneous equilibrium and material balance calculations may be made graphically in two ways, the simplest using an XY (mol fraction of one component in liquid phase vs. mol fraction of same component in vapor phase) diagram for the system and the other using an enthalpy-composition (HX) diagram for the system. With the XY graphical method, constant molal overflow is assumed, whereas with the HX it is not necessary to make this simplifying assumption. With the XY diagram method, simultaneous equilibrium and material balance calculations are made stepwise. With the HX diagram method simultaneous phase equilibrium and heat balance calculations are made at each theoretical stage graphically, taking into account the variations in the molal overflow quantities automatically. Both of these graphical methods are of considerable interest from the theoretical standpoint as they are quite helpful in understanding the mechanism of distillation operations. Also they suggest shortcuts that may be applied to multicomponent distillation calculations.

A strictly rigorous calculation for the absorption or fractionation of multicomponent hydrocarbon mixtures would involve simultaneous partial differential equations for all of the components present. These equations would include the diffusional and vaporizational interphase transfer, and also heat and material balance considerations. Such equations would do more than formulate the multiplication of the enriching and depleting operations that occur on individual stages. If rigorous, these expressions would include the internal action that takes place in each stage, which necessarily gives consideration to the flow pattern within as well as between the various stages. In the case of a packed or differential process the changes are continuous and would be represented by uniform functions.

The use of such equations would be very complex and would undoubtedly require electronic calculating devices for their solution. At the present state of knowledge it is obviously impractical to strive for the precision that such rigorous solutions of absorption and fractionation operations would make possible. Accordingly, simplifications are made to permit executing process design calculations with reasonable accuracy and in a reasonable length of time. One of the most important simplifications made in this direction is the use of the theoretical plate concept. The theoretical plate is a contracting stage wherein equilibrium is reached between the vapor and the liquid. In the case of packed columns it has been the practice to use a height equivalent to a theoretical plate.



—Courtesy of Foster Wheeler Corporation.

FIG. 1. Symbolic fractionator indicating process design calculation steps.

Various types of theoretical plate-component distribution calculation methods have been proposed. Although these methods are based upon the same fundamentals they differ in the procedure as determined by the starting point and the objective of the calculations. Because of large numbers of variables, or the many degrees of freedom, it is always necessary to start off any absorption or fractionation calculations by making assumptions to get started. These assumptions may be classified as *primary* and *secondary* assumptions, depending upon the particular problem at hand. For example, the primary assumptions might be the number of theoretical plates and the heat input, while the secondary assumptions might be temperature gradient and the product compositions. With these as a starting point, calculations will determine the compositions of the products obtained and check the temperatures for the given primary assumptions.

Various calculation methods and procedures have been proposed. All of these will be described and discussed in subsequent articles of this series. Some of these methods are short-cut approximations, some are graphical stepwise methods, some are empirical methods using minimum reflux and minimum plates as limiting conditions, and some are overall equations employing effective absorption and stripping factors, etc. The mechanics of these methods involve equations and graphs, which are based in part on theory and in part on calculated and experimental results.

The question often arises as to the wisdom of going to so much trouble in making the theoretical plate and component distribution calculations when the plate efficiencies are usually uncertain anyway. It is true that plate efficiencies are not very well known, but the only way plate efficiencies can be determined is by analyzing performance data, and for this, component calculation methods are necessary. Also it is frequently necessary to compute the component distribution between the products, even though the plate efficiencies and the number of plates may be uncertain. This arises from the necessity of knowing what the products are going to be in order to make guarantees and so forth.

Fig. 1 is a symbolic design of a fractionator with the various process design calculations steps indicated. These steps are not necessarily listed in the order that would be followed in making the calculations. This figure serves to illustrate some of the computations that are required. It will be noted that some of the computations require thermodynamic data, namely: phase equilibria and heat balances. Others require methods for carrying the multicomponent equilibrium and material balance calculations from stage-to-stage.

Referring to Fig. 1, it will be noted that some of the calculation steps are based on empirically determined factors that must be obtained by analyzing plant performance data. Thus it can be seen that the process design calculation steps involve three types of information, namely: thermodynamic data, mathematical methods, and plant performance factors. The source of these three design tools are of course different and it is important that they all be consistent. The thermodynamic data are obtained by applying the basic laws of thermodynamics to the volumetric and calorimetric behavior method of hydrocarbons. The mathematical calculation methods are derived by combining the equilibrium and component material balance relationships to given analytical or graphical solutions. The empirical design factors are obtained by analyzing plant performance data on the same type of equipment. In analyzing performance data it is necessary to use the thermodynamic and the mathematical tools. Plate efficiencies are obtained by analyzing performance data using

phase equilibria data and a component calculation method. The resulting plate efficiencies therefore are not necessarily valid for other phase equilibria data and other component calculation data methods. For these reasons it is very important that the fundamental data and the calculation methods used be consistent.

DESCRIPTION of PROCESSES

In preparation for the more detailed technical treatment of the absorption-stripping and fractionation processes to follow in the subsequent articles of this series, brief descriptions will be presented here to outline these processes in a general way without going into any details.

Fig. 2 is a schematic diagram showing the paths of flow of the various streams within the absorption-stripping system. For purposes of illustration the diagram is drawn as though there were four individual streams involved, namely: The residue gas, the stripping steam, the recovered components, and the lean oil. The residue gas and recovered components constitute the wet gas feed to the bottom of the absorber. The lean oil and the recovered components constitute the rich oil flowing from the absorber to the stripper. The steam and the recovered components leave the stripper together.

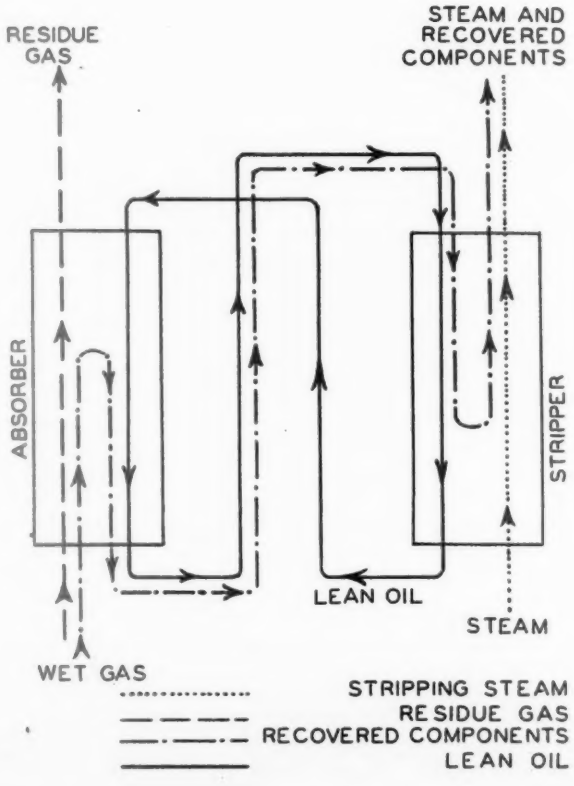
At the absorber the interphase transfer is principally in the direction of gas to liquid, although there is some transfer in the opposite direction. This usually occurs in the bottom of the absorber where the light constituents such as methane and ethane are stripped out of the rich oil by the incoming feed gas. The fact that there is interphase transfer in both directions does not make the absorption process an equilibrium operation. Instead it is a diffusional operation with absorption predominating and with some stripping.

In the stripper the action is in the opposite direction, i.e., the interphase transfer of the components is from the liquid to the gas. Likewise there is usually some absorption at the top of the stripper where the heavier components in the vapor might be reabsorbed by the incoming rich oil. By the same logic that applies to the absorption part of this process, it may be stated that the presence of interphase transfer from vapor to liquid as well as liquid to gas does not make the stripper an equilibrium process. It is also a diffusional process with stripping predominating and with a small amount of absorption.

Fractionation is frequently described as a vaporizational-condensational operation. This type of mechanism is illustrated on Fig. 3, which is a schematic diagram showing successive vaporization and condensation. In the system illustrated in Fig. 3, the charge is flash vaporized and the resulting vapor and liquid are each flash vaporized again. The liquid residue from vaporizing the distillate is combined with the vapor overhead from vaporizing the residue of the resulting mixture again vaporized. This successive vaporization and condensation with a recombining as shown in Fig. 3 may be carried out to the point where the distillate and the residue products are sharply split. However, the type of operation shown on Fig. 3 is not a practical scheme, because there is no way for the intermediate fractions to find their way to the end products. Accordingly, the successive vaporization and condensation operations that make up fractional distillation are carried out another way. The system shown on Fig. 3 is of theoretical and academic interest only. Although the distillate and residue produced by such a series of successive vaporizations and condensations would be sharply separated, the yields are low. The system on Fig 3 needs a means of recycling those components that get out of the direct line to the top or bottom. This can be accomplished very easily by combining some of the stages by telescoping the diagram in the horizontal direction to give one vertical column of stages, as shown on Fig. 4.

Fig. 4 shows the fractionator as a series of equilibrium flash vaporization stages, each stage being fed vapor from the stage below and liquid from the stage above. The stages above the feed point constitute the *enriching* section, whereas the stages below the feed point constitute the *stripping* section. With this concept of fractionation the vapor and liquid leaving each stage are assumed to be in equilibrium even though this is not always true in practice. In some cases the commercial contact will carry the

FIG. 2. Schematic diagram showing paths of flow in absorption-stripping system.



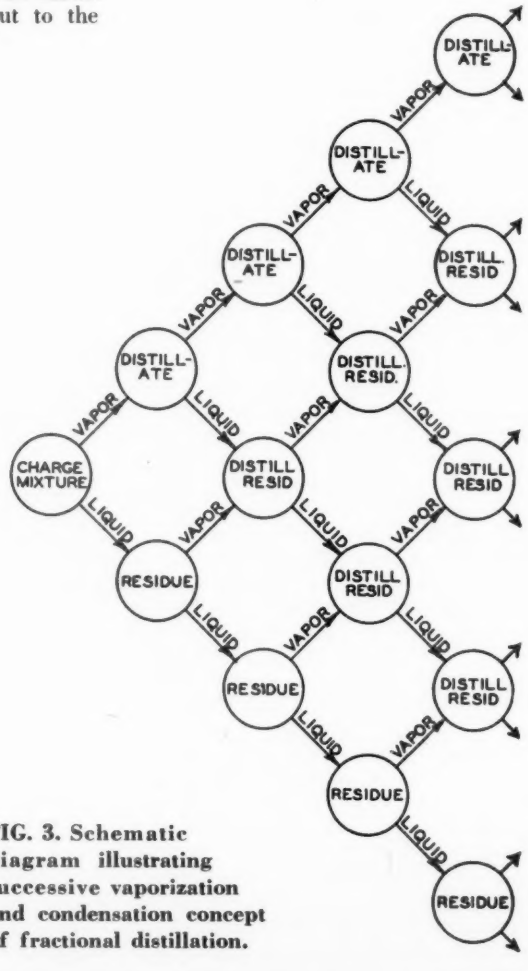


FIG. 3. Schematic diagram illustrating successive vaporization and condensation concept of fractional distillation.

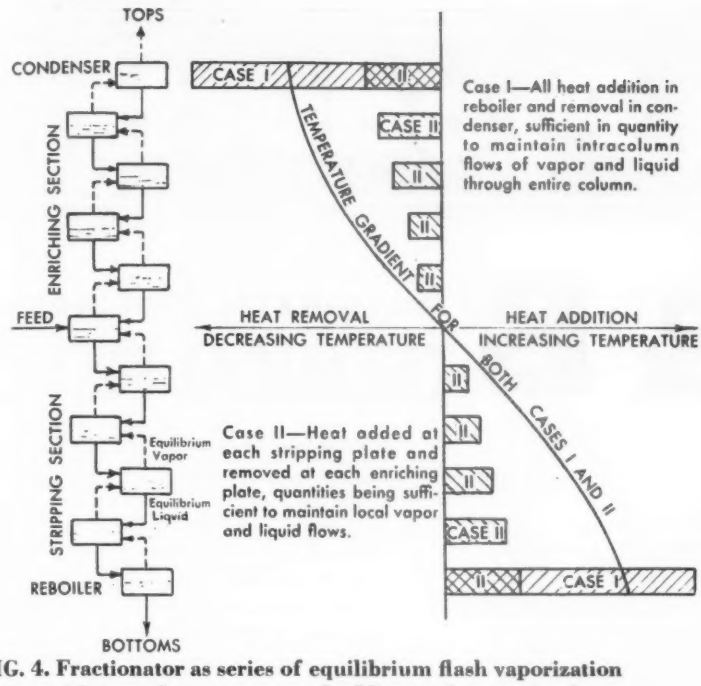

TOPS
CONDENSER
ENRICHING SECTION
FEED
STRIPPING SECTION
Equilibrium Vapor
Equilibrium Liquid
REBOILER
BOTTOMS
CASE I
CASE II
TEMPERATURE GRADIENT FOR BOTH CASES I AND II
HEAT REMOVAL
DECREASING TEMPERATURE
HEAT ADDITION
INCREASING TEMPERATURE
Case I—All heat addition in reboiler and removal in condenser, sufficient in quantity to maintain intracolumn flows of vapor and liquid through entire column.
Case II—Heat added at each stripping plate and removed at each enriching plate, quantities being sufficient to maintain local vapor and liquid flows.

FIG. 4. Fractionator as series of equilibrium flash vaporization stages with two alternate ways of adding and removing heat.

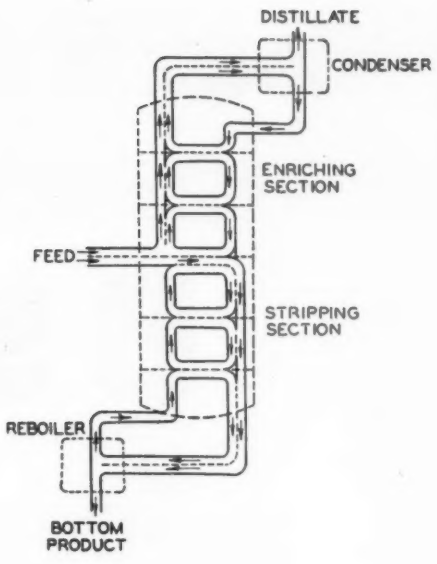


FIG. 5. Schematic diagram of fractionator showing flows of liquid and vapor.

interphase transfer of components further than the equilibrium, and in other cases it will not reach equilibrium.

Also shown on Fig. 4 is a bar chart representing two methods of adding and removing heat from a fractionator. On this graph is also shown the temperature gradient for two cases of heat addition and removal. In Case I all of the heat is added in the reboiler and all the heat rejection takes place in the condenser. Thus all of the heat that is added at the high temperature level at the bottom of the column flows through the column to the condenser where it is rejected at a lower temperature level. The amount of heat that must be added in the reboiler for Case I is more than sufficient to maintain the required interstage flows of vapor and liquid at that point. The excessive heat added in the reboiler is really required higher up in the colum. Accordingly, the same separation may be obtained by adding the heat in increments at the different stages in the stripping section and removing heat incrementally at different stages in the enriching section, as shown in Case II.

These two alternate ways of adding and removing heat in a fractionator illustrate an important point, namely: that heat may be added and removed at intermediate points in a fractionator without impairing the separation efficiency but at the same time improving the thermodynamic efficiency, and also decreasing the column capacity requirements at critical points. In commercial installations it is not practical to carry this multipoint heat addition and removal as far as shown on Case II of Fig. 4. However, it is frequently desirable to use intermediate reflux and also add heat at intermediate points. These are particularly desirable when there is a use for the heat that could be removed at an intermediate point and when a lower level heat is available for reboiling.

The interstage flows of vapor and liquid in a fractionating column are shown diagrammatically on Fig. 5, which represents an improved and practical case of the fractionator system shown in Fig. 4. Referring to Fig. 5, it will be noted that there is a net upward flow of vapor equal to the amount of the distillate in the enriching section and a net downward flow of liquid equal to the amount of the bottom product in the stripping section. In addition there is a recycle of materials from stage-to-stage in each of these sections. It is by means of this recycling type of interstage flow that the interphase transfer of components takes place. In subsequent articles of this series equations and graphs will be developed for making the calculations for the operation shown on Fig. 5.

Absorption and stripping are not illustrated in the same way because of the different mechanisms that take place. Accordingly different methods will be presented for absorption and stripping.

The above description covers absorption and fractionation operations in a general and theoretical way. These processes are used in commercial plants in various forms. Most of these installations involve the use of bubble tray columns and these bubble trays are usually built with caps and downcomers, although perforated plates may be used.

Commercial installation of these processes ordinarily involves installing sufficient stages in one tower to carry out the operation, but it is frequently necessary to have two towers operating in series. An example of this is a fractionator consisting of an enriching section in one tower and a stripping section in a second tower. The two towers being connected at the bottom of the enriching section and the top of the stripping section by means of vapor and liquid lines.

Another commercial installation of interest is the reboiled absorber. In this type of equipment a reboiling section is put on the bottom of the absorber in order to boil out the methane and ethane so as to permit liquefying the recovered components. Another addition frequently made to an absorber is to add a sponge oil section on the top through which a heavy solvent is circulated to reduce the loss of the main solvent.

Most absorption and fractionating equipment are integrated with conversion processes and in this service there is frequently some recycling of gas or liquid or both. This makes the design more complex, because it is not possible to establish definite conditions for each individual tower without considering the rest of the system. The proper selection of operating conditions to suit the processing requirements, the utilities available and also the economics involved are all necessary steps in the process design of hydrocarbon absorption and fractionation equipment.

General References

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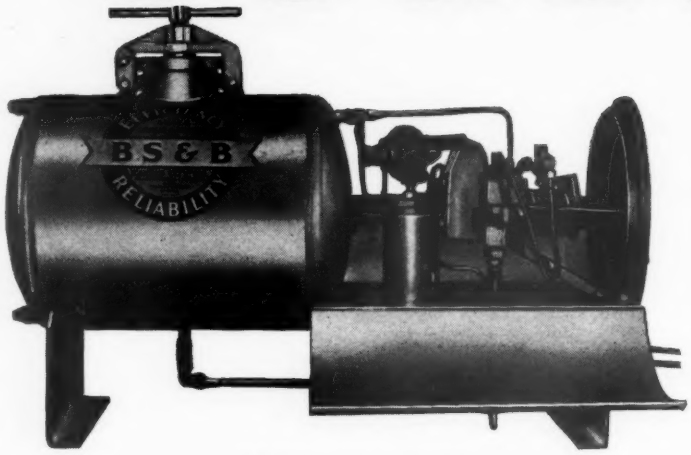

SPECIFICATIONS

Maximum Chemical Output per Day—12½ gallons with ⅜" piston; 50 gallons with ¾" piston.
Capacity of Chemical Tank—10 gallons.
Piston Sizes—⅜" and ¾".
Overall Size—1' 2" wide—3' 3" long—2' 1" high.

Does your business have a tough problem requiring precise timed feeding? The B S & B Chemical Feeder accurately injects liquids into high pressure lines, treating chemicals into flow lines, paraffin solvents into well casings, methanol into gas lines . . . handles many other similar jobs in refineries and process industries. Yes, sir . . . this sturdy, compact unit is adaptable to a variety of jobs . . . and it might be the solution to your problem! Operates inexpensively on air or gas pressure of 20 to 50 psi. Achieves wide flexibility of discharge . . . up to 10,000 psi! Equally efficient with light or heavy viscous chemicals.

Available for immediate delivery. Completely self-contained chemical tank and pump unit. Ruggedly built to perform accurate service with a minimum of attention. It's the "Little Fellow with the Big Push!"

BS & B Pressure-Vacuum VENT VALVES

SPECIFICATIONS

Diameter, in inches—2, 3, 4, 6, 8, 10, 12, 16, 20, and 24.
Standard opening pressures—1½ to 3 ounces.
Maximum opening pressures—4 to 16 ounces.
Standard opening vacuum—½ ounce.
Write for detailed specifications.

Here's positive protection against vapor loss when storing benzol, alcohol, gasoline and other products requiring slight pressure for economical storage. B S & B Vent Valves guard against both overpressure and excessive vacuum. An exclusive flexible gasket provides a tight seal during normal operations. Overpressure lifts the hinged cover, breaks the seal, allows vapors to escape until normal pressure is restored. Excessive vacuum causes atmospheric pressure to lift the gasket, permitting inbreathing.

B S & B Vent Valves are available in a full range of sizes . . . 2 to 24 inches. Standard models have cast iron body and cast aluminum cover; B S & B Vent Valves are also available in bronze, monel, stainless or combinations of these metals. Larger Vent Valves also may be used as manhole openings. Many are in use as supplementary relief valves.

• BUILT TO DO THE TOUGHEST JOBS WITHOUT COMPLAINT!

B S & B
SAFETY HEADS

Control the danger of overpressure with B S & B SAFETY HEADS. Wherever you have a liquid or gas under pressure, SAFETY HEADS give instant relief when needed. These remarkable metal rupture diaphragms burst in tension at pre-determined pressures and temperatures... provide full-throated, positive relief. No other pressure relief device offers such complete protection with such economy. No other device can approach the relief capacity of a SAFETY HEAD in a given diameter.

There is a SAFETY HEAD to fit every need... from 5 to 25,000 psi. Simple, versatile, dependable. New SAFETY HEAD diaphragms are guaranteed to burst within *five per cent* of specified pressure at stated temperature! You can choose the SAFETY HEAD for your individual needs from the great variety of types. Tailor-made safety... constant, reliable, tamper-proof. Quickly and easily replaced.

Thousands of plants rely on SAFETY HEADS. You, too, can put them to work in your plant. Be safe, be sure ...with SAFETY HEADS!

Write TODAY for Latest Catalogs

All the facts . . . specifications, performance records, applications, complete descriptions . . . in our three latest catalogs on the Chemical Feeder, Vent Valves, SAFETY HEADS. State which product . . . or ask for all three! Address Special Products Division, Black, Sivalls & Bryson, Inc., Power and Light Building, Kansas City 6, Missouri. *Do it now!*

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RELIABILITY

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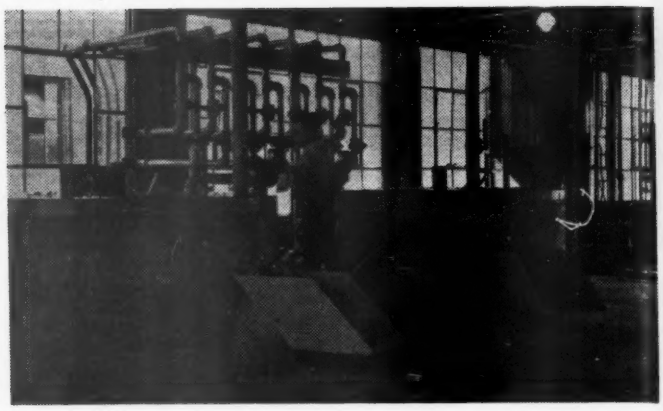
New process for making grease continuously



EXCLUSIVE *Petroleum* **Engineer** **Picture** *Story*

A NEW process for making grease continuously, which is said to give far finer quality than the conventional batch method, is now in operation at Martinez Refinery of Shell Oil Company, Inc.

The plant is the only one of its kind in the West. Many of its features are exclusive with Shell and represent a big step forward in the manufacture of lubricants. The new equipment required an investment of approximately $150,000.

In addition to turning out a complete line of aluminum base greases for agricultural and industrial applications, the plant also is making an entirely new line of lithium base greases for aircraft and industrial lubrication. Shell's lithium base greases are impervious to water and are adaptable to both very high and very low temperature operations. It is expected that they will find even wider uses later on.

Shell's new grease-making process starts in these slurry kettles at Martinez. Flow of oil into the slurry tanks is controlled by the manifold. G. P. Nelson, assistant department manager, talks with R. F. Knapp, the operator, beside the tanks. A more inclusive view is shown above.

EDWARD CONTRIBUTIONS TO BETTER VALVE PERFORMANCE

VITAL Edward AIDS

TO YOUR VALVES' EFFICIENCY

Because of Edward engineering and research, better valves are available to you. Among the Edward developments you can now specify are these:

EValloy (stainless steel)—Processed to Edward specifications growing out of years of stainless steel pressure-temperature research, this material lengthens life of stems, seats, disks, disk nuts, piston rings and other parts.

IMPACTOR Handwheel—Closes big valves in little spaces against high pressures with sledge-hammer blows, saving the cost of motor operators and the bulk of toggle operators.

EValthrust Yoke Bushing—Double combination angular—radial ball bearings to insure smooth, positive closing.

EVALIZING An exclusive plating process which reduces friction between moving steel parts by approximately 50 per cent.

EVinlay—A hardened bearing surface for bonnet nuts and stem contact areas on the disks of large high-temperature valves to prevent seizing and galling.

EValpak Heat resisting molded packing of graphite-impregnated asbestos, especially formed for Edward stuffing boxes.

Equalizer—Permits full lift of piston in non-return and check valves for lower pressure drop.

INTEX Integral seat valves of extra value; for pressures to 1500 lb at 950 F.

UNIVALVE Integral bonnet forged steel valves for service extremes.

* * *

To build good valves and to develop better ones; that is the dual purpose of this business.

* * *

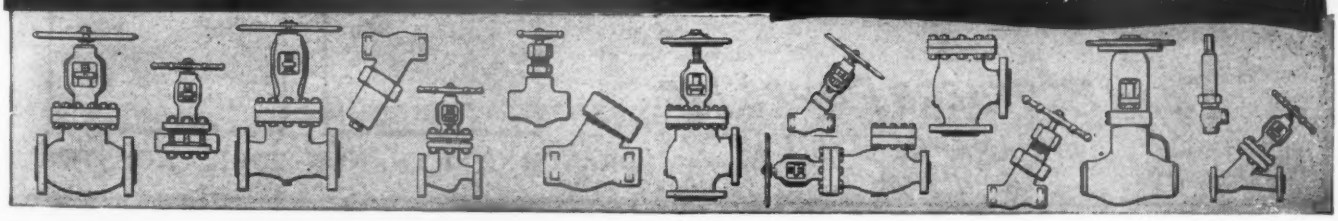
EValloy, Impactor, EValthrust, EValizing, EVinlay, EValpak, Equalizer, Intex, Univalve and Valve Values are registered trade names of Edward Valves, Inc.

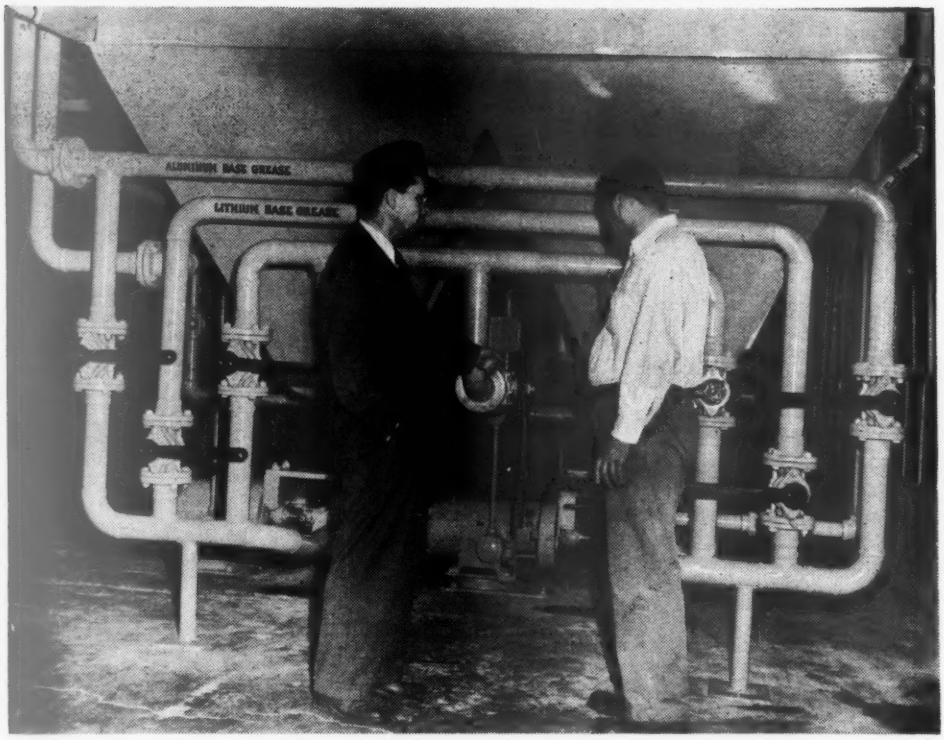
ROCKWELL

Edward Valves, Inc.

Subsidiary of Rockwell Manufacturing Company

EAST CHICAGO, INDIANA





On the bottom floor of the compound house are the collecting tanks where James McLaren, department manager, is shown with E. E. Baroni, head compounder, in the above picture. From these tanks the greases flow to the homogenizer.

Greases usually are made in batches by heating and mixing the ingredients in autoclaves or kettles, with paddles to provide agitation, as in an ice-cream churn, until the proper consistency is obtained. With certain soaps, notably calcium and sodium, the batch process turns out very satisfactory lubricants; but in the case of aluminum greases conditions of cooling are much more critical for the formation of a satisfactory grease structure and by the batch method several days are required for cooling in pans and mixing to a homogeneous product.

Shell's new grease facilities have streamlined operation. The ingredients go in continuously and specification products are pumped directly into waiting containers. There is no handling en route. Temperatures are controlled automatically and exactly by thermostats. Cooking time is reduced. The sealed "production line" prevents any possibility of contamination.

Nomads of Los Angeles, California, will hold their annual "Whing-Ding" at the Riveria Country Club July 18. There will be no regular meeting in July.

DEAN BROTHERS PUMPS INC. INDEANAPOLIS, INDEANA. PUMPING MACHINERY

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BUILDERS OF OUTSTANDING PUMPS SINCE 1869

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MARSH ALONE HAS THE "RECALIBRATOR"—quickest and most satisfactory way to correct a gauge that has been knocked out of adjustment through improper handling.

Marsh branch plant at Houston offers shipment from stock, facilities for repairing all gauges

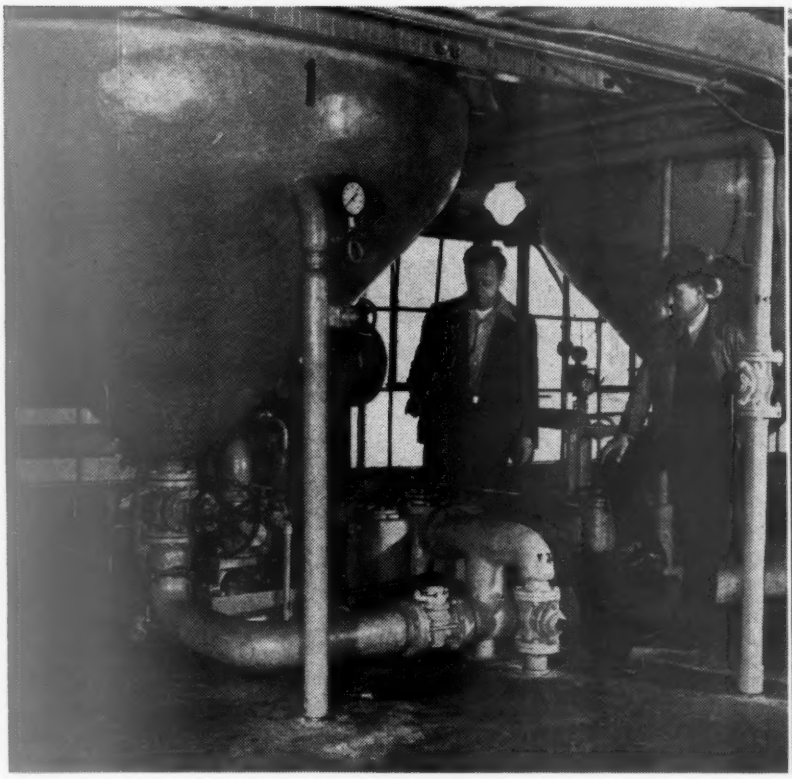
• Wherever you are, there's a supply of Marsh Pressure Gauges nearby. We have not only developed pressure gauges for every phase of the petroleum industry, we have also made them available wherever oil is produced, transported or refined. To further expedite distribution and service in the oil country there is a Marsh branch plant at Houston with complete facilities for servicing all makes of pressure gauges.

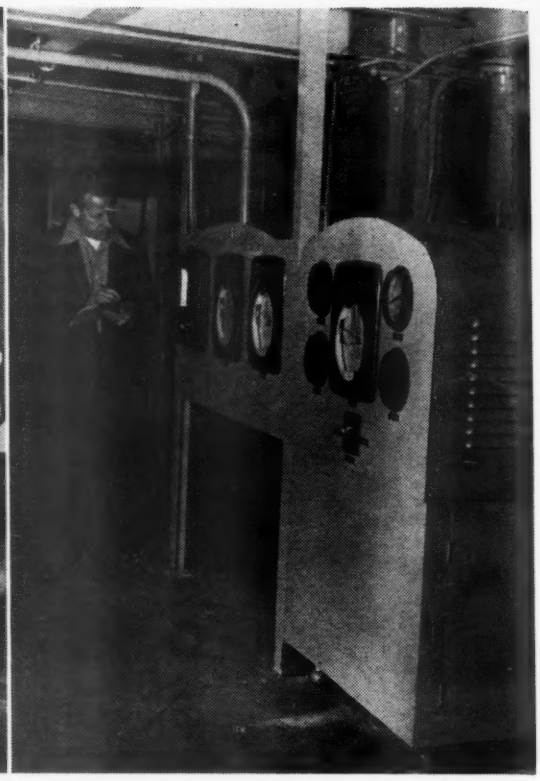
The harder you are to please, the better you will like these gauges that are engineered down to the last detail for every service encountered in the oil industry. In the Marsh Mastergauge you have an instrument guaranteed accurate within ½ of 1% of reading—a gauge with a finer monel and stainless steel movement, lathe turned bourdon tube and moistureproof, vaporproof case—a gauge that sets a new standard for quality and stamina.

The Mastergauge is made in types for every application—as a Christmas tree gauge, an oil country boiler gauge, and with effective diaphragm protection as a mud pump gauge. The line includes the finest of hydraulic gauges and Reid Vapor Test gauges. Ask for new oil industry bulletin containing convincing facts about Marsh Gauges.

JAS. P. MARSH CORPORATION, 2049 Southport Ave., Chicago 14, Ill.

"THE STANDARD OF ACCURACY"





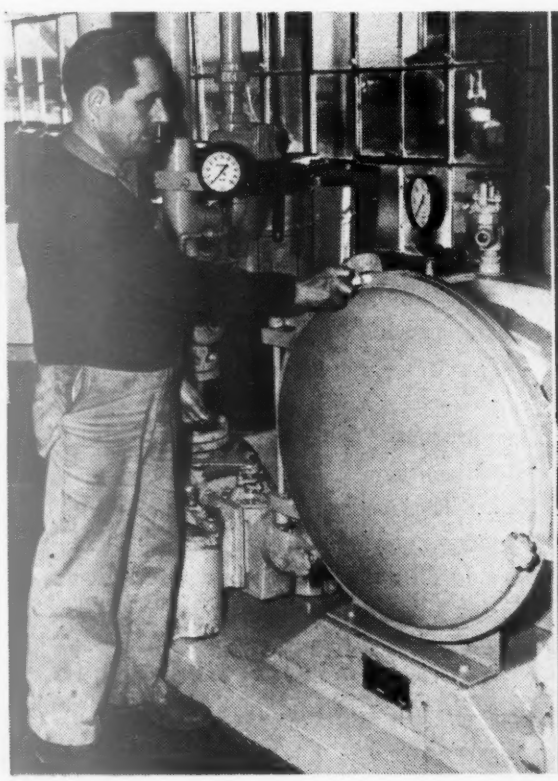
Leaving the kettles, which extend through the floor of the compound house, the slurry flows through the homogenizer shown above. Roy L. Peterson, operating assistant in charge of compounding, tells L. Klingen, who was in charge of equipment installation, that things are running nicely.

Roy L. Peterson, at top right, checks a reading.

The homogenizer, at left below, is used to increase the quality of the final grease texture. E. O. J. Oliver, working beside it, is foreman of grease filling.

An important part of the process is the new method of continuous homogenization, which gives a more uniform product. Special devices mill the grease just prior to filling into containers. The resultant texture is smoother and more buttery. Shell's new aluminum greases show no graininess and have the clarity of a well refined lubricating oil.

Filled drums are now ready for consumers. W. J. Pawsey, fork truck operator, picks up a load of drums to be loaded for shipment in the scene below. ★ ★ ★



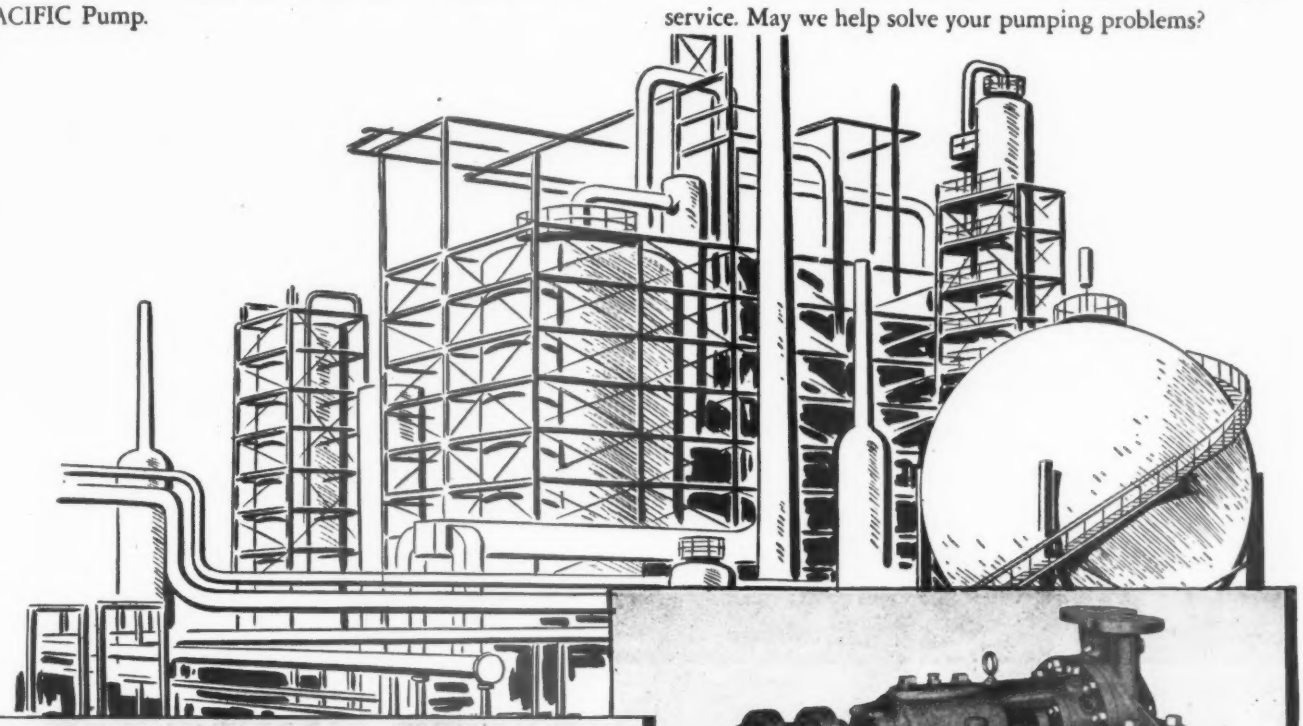
Solve Your Refinery Pumping Problems With

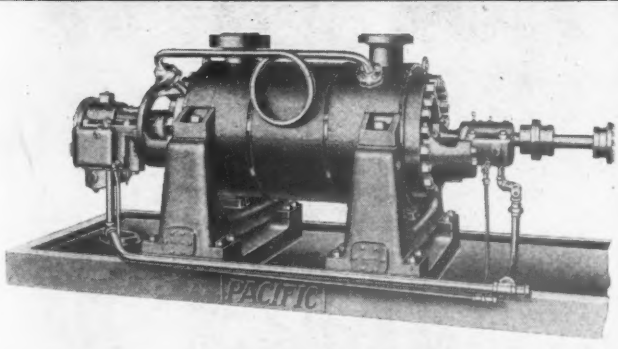
PACIFIC PUMPS

For nearly a quarter century, PACIFIC has concentrated upon the design and construction of Centrifugal Pumps to meet the exacting requirements of the petroleum refining and allied process industries. The knowledge gained by this experience is reflected in the design and efficiency of each PACIFIC Pump.

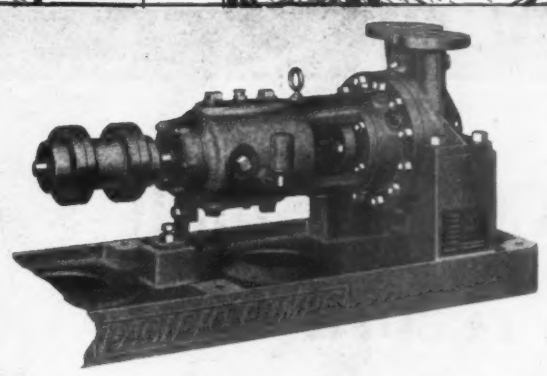
Whether it be for general service pumping . . . or for the handling of light or heavy, corrosive or non-corrosive liquids at the highest pressures and most extreme temperatures . . . there is a PACIFIC Pump designed and constructed from materials selected for the specific service.

PACIFIC'S staff of experienced engineers are at your service. May we help solve your pumping problems?





PACIFIC Type ITB Hot Oil Pumps. Capacities from 50 to 2700 g.p.m. Temperatures up to 850°F. Differential pressures to 2500 p.s.i.



PACIFIC Type SVC Pumps. Capacities from 15 to 1600 g.p.m. Operating temperatures from sub zero to 800°F. Discharge pressures to 600 p.s.i.

For Pumps designed to meet special operating conditions *look to PACIFIC*
For rugged performance, safety and low maintenance cost *specify PACIFIC*

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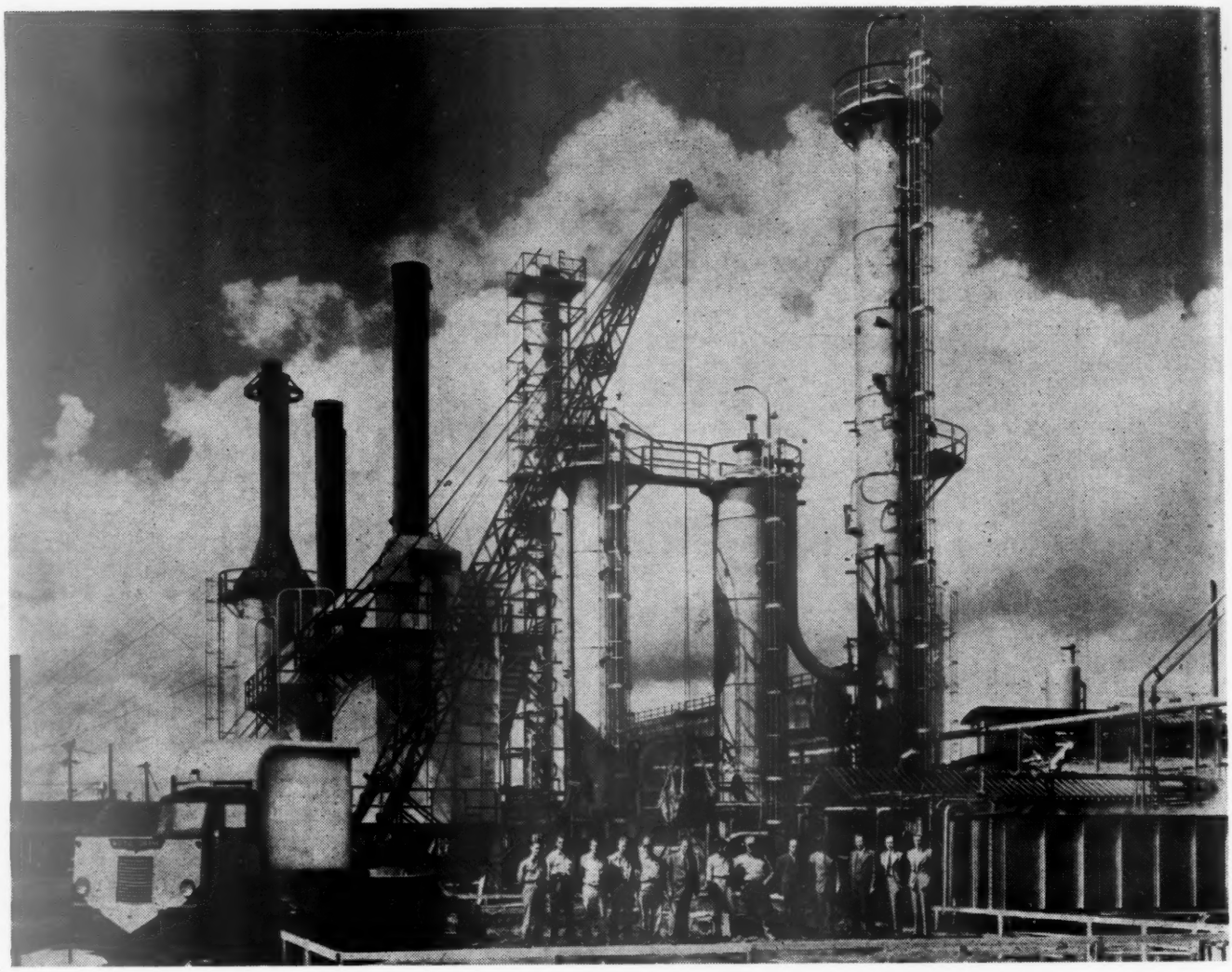
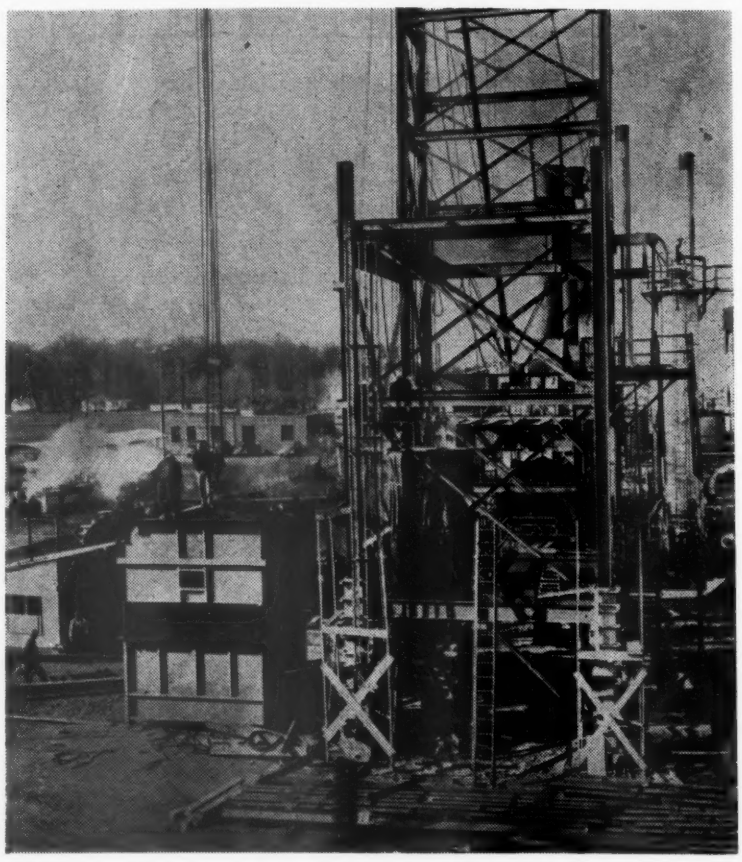


TCC unit built in record time

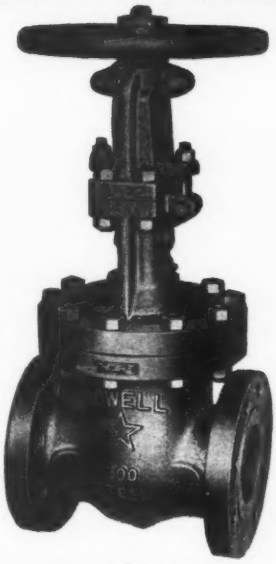
A Petroleum Engineer Picture Story



September 9, 1946, Catalytic Construction Company, subsidiary of Houdry Process Corporation, began its record-breaking job of building the first postwar catalytic cracker—a TCC unit—designed to meet the competitive needs of the small refiner. Ground was broken at Leonard Refineries, Inc., Alma, Michigan, on this date. (See photo above.) The unit was completed in five months.

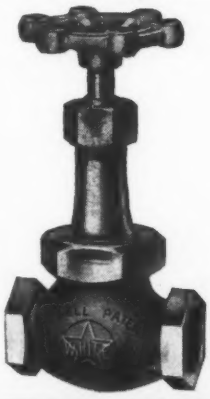
October 26, main structure foundations completed and erection of main steel structure progressing, at right. Work on fireproofing of main columns as well as refractory brick lining of air heater has begun. Here rigging is being installed for erecting the bottom section of kiln. This section is approximately 11 by 11 by 18 ft and weighs 13 tons. Steel erection continues with the use of a basket-type pole shown in the center.

depends on *perfect* control.



Class 300-pound Cast Steel Gate Valve with bolted flanged yoke, outside screw rising stem and taper wedge solid disc. Powell Cast Steel Valves of all types are available in pressure classes from 150 to 2500 pounds, inclusive.

Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. made in sizes 2" to 30", incl. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Taper wedge double discs can be provided in sizes 2" to 12", incl. Also available in All Iron for process lines.



Small size 200-pound Bronze Globe Valve for steam, water, oil or gas. For assured, long-life performance, it has a renewable, specially heat treated stainless steel seat and regrindable, renewable, wear-resisting "Powellium" nickel-bronze, plug type disc.

The performance of an orchestra depends on the control exercised by the conductor. Without this control, the greatest aggregation of musicians in the world would make a sorry mess of the finest symphony.

Likewise, the smooth performance of an industrial plant depends on the valves which control the media necessary to its operation. And for perfect performance in flow control, the valves must be adapted in every way to the conditions under which they operate.

For more than a century, Powell Engineers have been designing valves to meet every new flow control condition as it has arisen.

Today there's a Powell Valve, in Bronze, Iron, or Cast Steel, for every known requirement of Industry. And to meet the demands of the Chemical and Process Industries for corrosion-resistant valves, Powell makes a complete line, including many special designs, in the widest range of pure metals and alloys ever used in making valves.

The Wm. Powell Company
Cincinnati 22, Ohio
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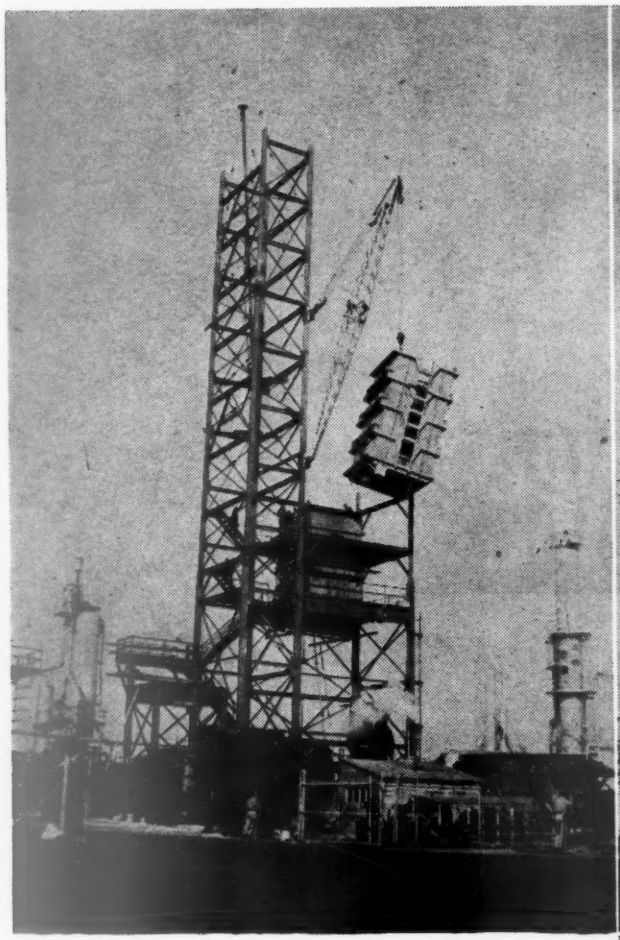
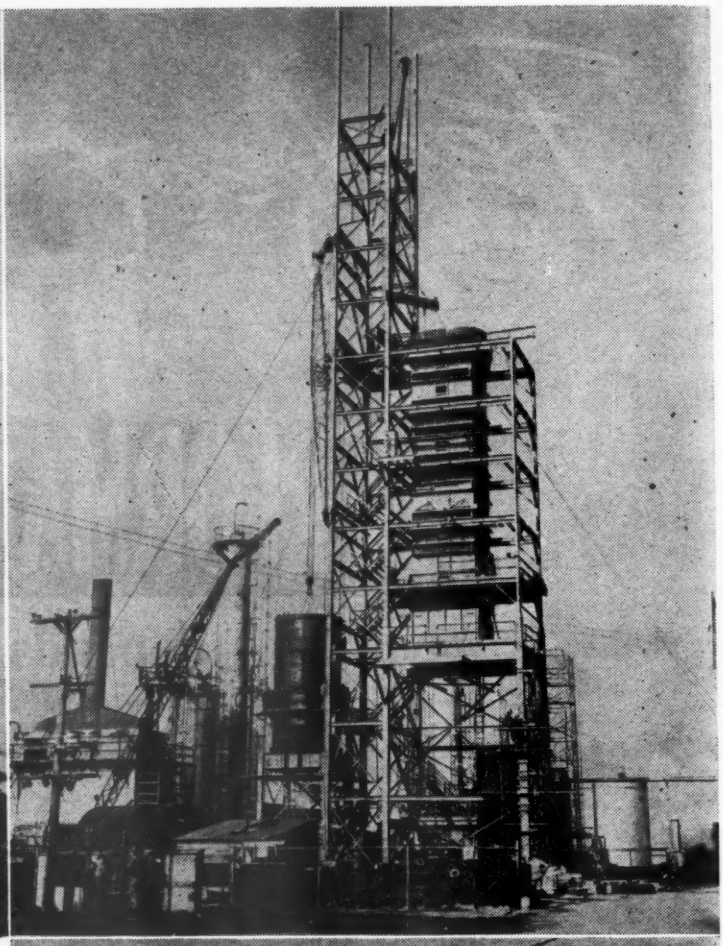
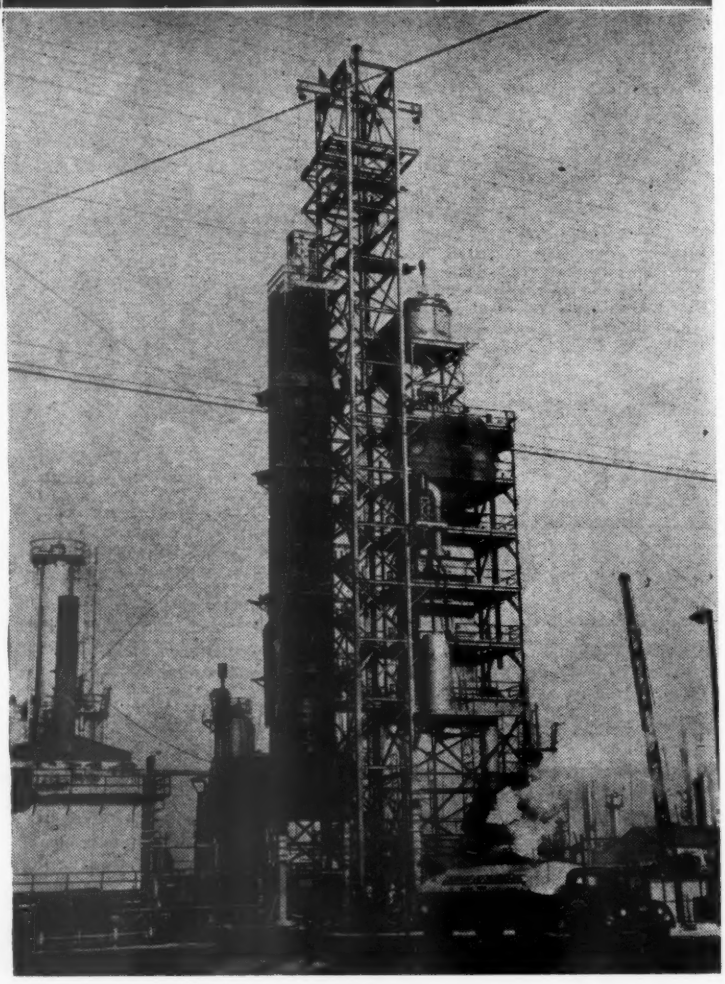
POWELL VALVES







Boom attached to the structure was capable of lifting approximately thirty tons and was used to raise the reactor and kiln, (above). This type of rigging resulted in maximum efficiency in time and use of equipment, and was well adapted to the space limitations of the work site.

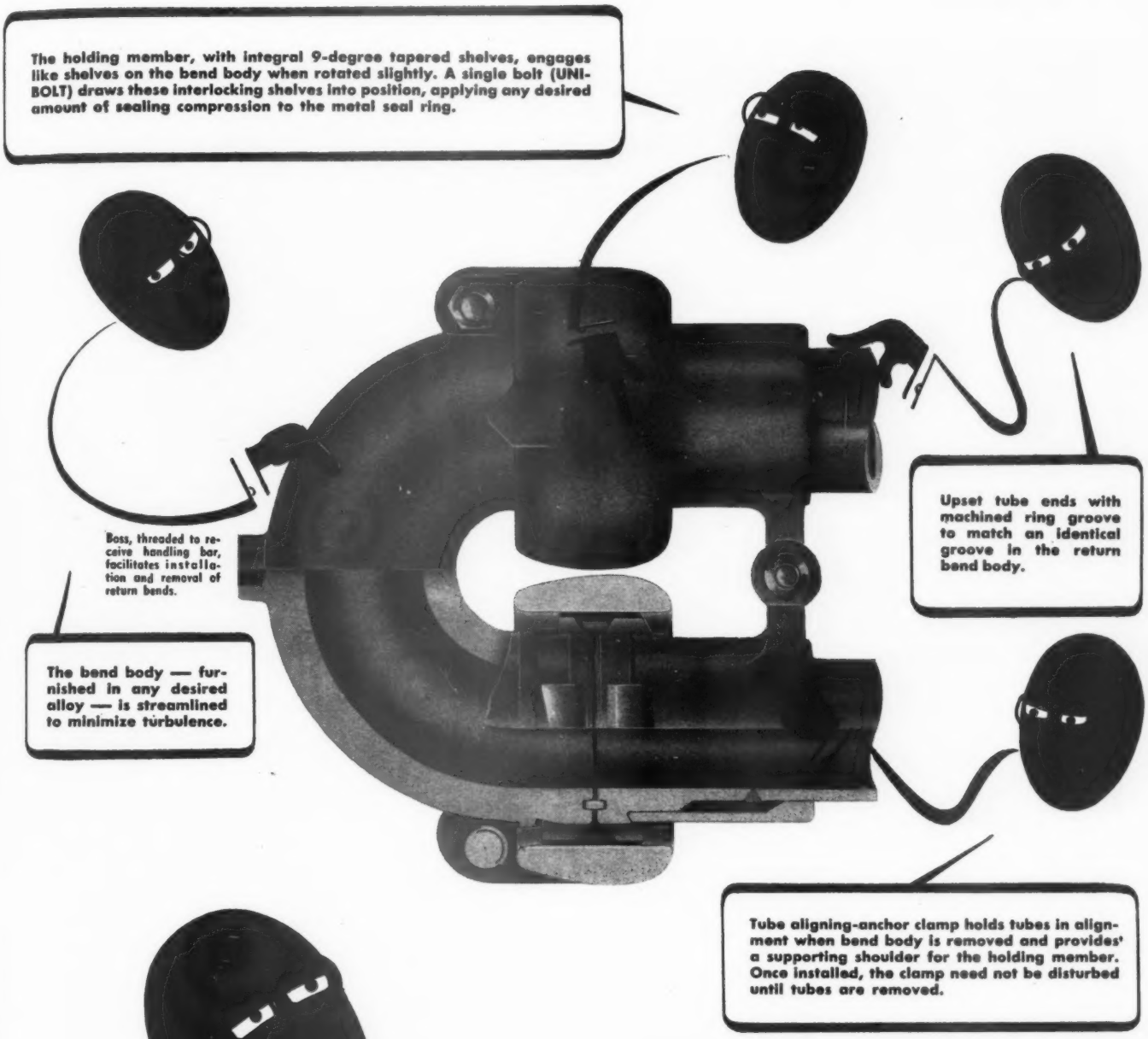
Because of the serious weather conditions encountered at the job site, several uncommon construction practices were adopted. Also, the proximity of other operating units of the Leonard refinery restricted the available working space.

Consequently, lifts of steel and equipment were made in as large sections as possible to cut down on the number of necessary tie-ins in the air. The insulation of the unit was installed at a time when the weather was most severe. It was necessary to heat the interior of the kiln in order to insure satisfactory work.

The exterior of the reactor, however, being entirely exposed to the cold and high winds, presented a difficult problem. A "U" shaped stage was constructed with complete enclosure of the working areas, and insulation of the reactor was started at the top. The stage was lowered from the boom by cables as the insulating work progressed.

November 21, second section of reactor 12 ft in diameter, 14 ft long, weighing fifteen tons, is in place and is being aligned preparatory to making field girth weld, top right. In the meantime, electrical conduit runs have been started and junction boxes are being installed.

December 19, catalyst hopper is being installed at top of kiln, right. Erection of piping has begun. Tarpaulin covered frame at base of reactor is used for protection of insulators in covering reactor column. Air duct from air heater to kiln has been started.


The holding member, with integral 9-degree tapered shelves, engages like shelves on the bend body when rotated slightly. A single bolt (UNI-BOLT) draws these interlocking shelves into position, applying any desired amount of sealing compression to the metal seal ring.
Boss, threaded to receive handling bar, facilitates installation and removal of return bends.
The bend body — furnished in any desired alloy — is streamlined to minimize turbulence.
Upset tube ends with machined ring groove to match an identical groove in the return bend body.
Tube aligning-anchor clamp holds tubes in alignment when bend body is removed and provides a supporting shoulder for the holding member. Once installed, the clamp need not be disturbed until tubes are removed.

THE RING'S THE THING

that enables UNIBOLT FURNACE FITTINGS *to seal the lightest gases at extreme temperatures*

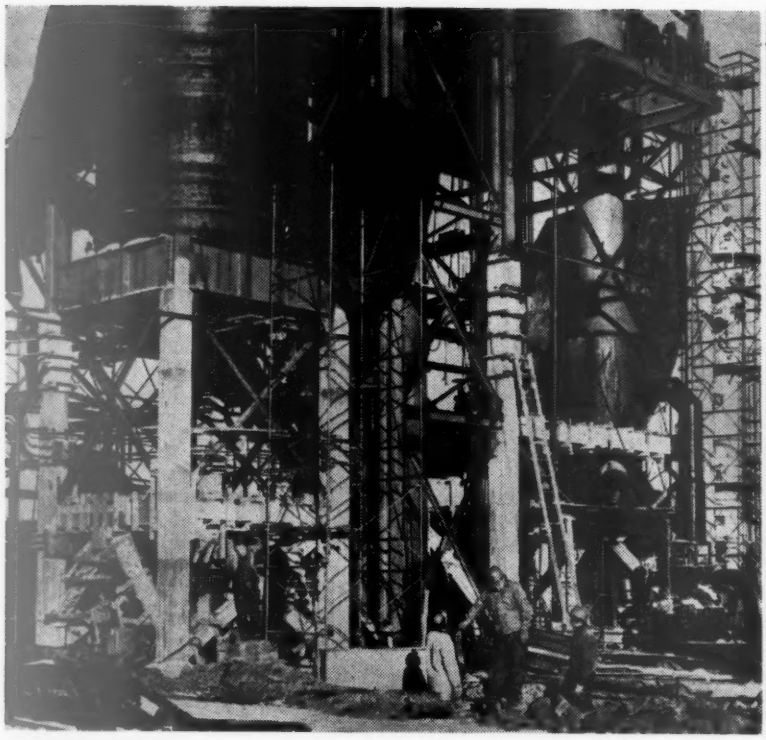
The UNIBOLT loose ring joint differs from other ring joints in that it (1) does not employ ring "distortion" to effect a seal, and (2) its seats are machined to extremely close tolerance and the seating load is accurately calculated, utilizing predetermined tube load, seating area and area exposed to pressure in a formula which has been unquestionably proven on furnace outlet temperatures ranging up to 1600 degrees F. and working pressures up to 8000 lbs. psi.

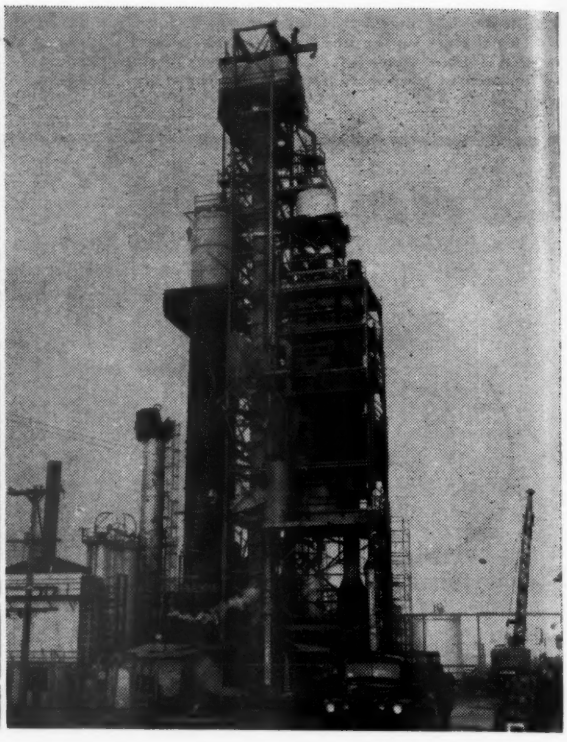
This positive seal is accomplished by tightening a single bolt . . . no rolled-in tubes, no seal welding, no tapered plug closures, no lapping to make a seal, no need for steam in the header boxes. They permit faster "heading-up," replacement of a single tube and returning any return bend body to any two tubes. Completely interchangeable parts assure low-cost maintenance.

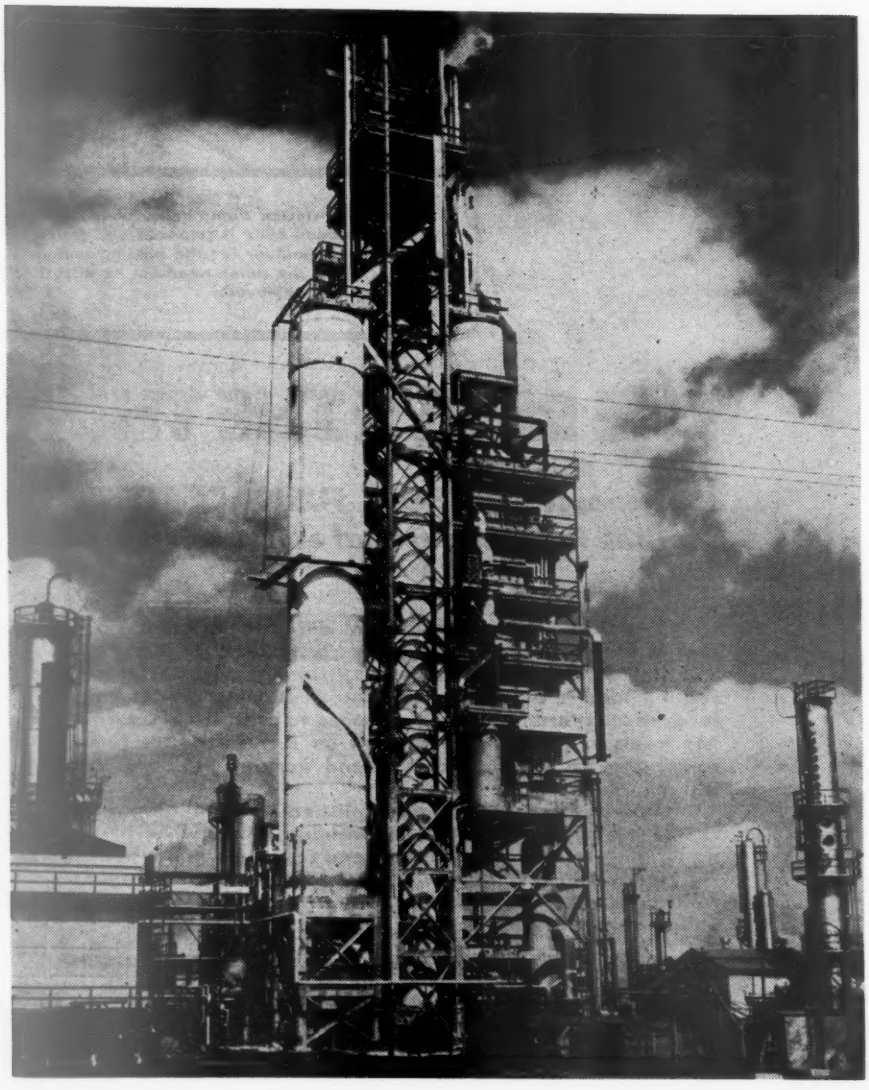
For complete details, write for Bulletin R-42.

THORNHILL-CRAVER COMPANY, INC.

HOUSTON UNIBOLT TEXAS







January 4, 1947, general ground view at top left. Conduit runs from structure to control house are being installed.

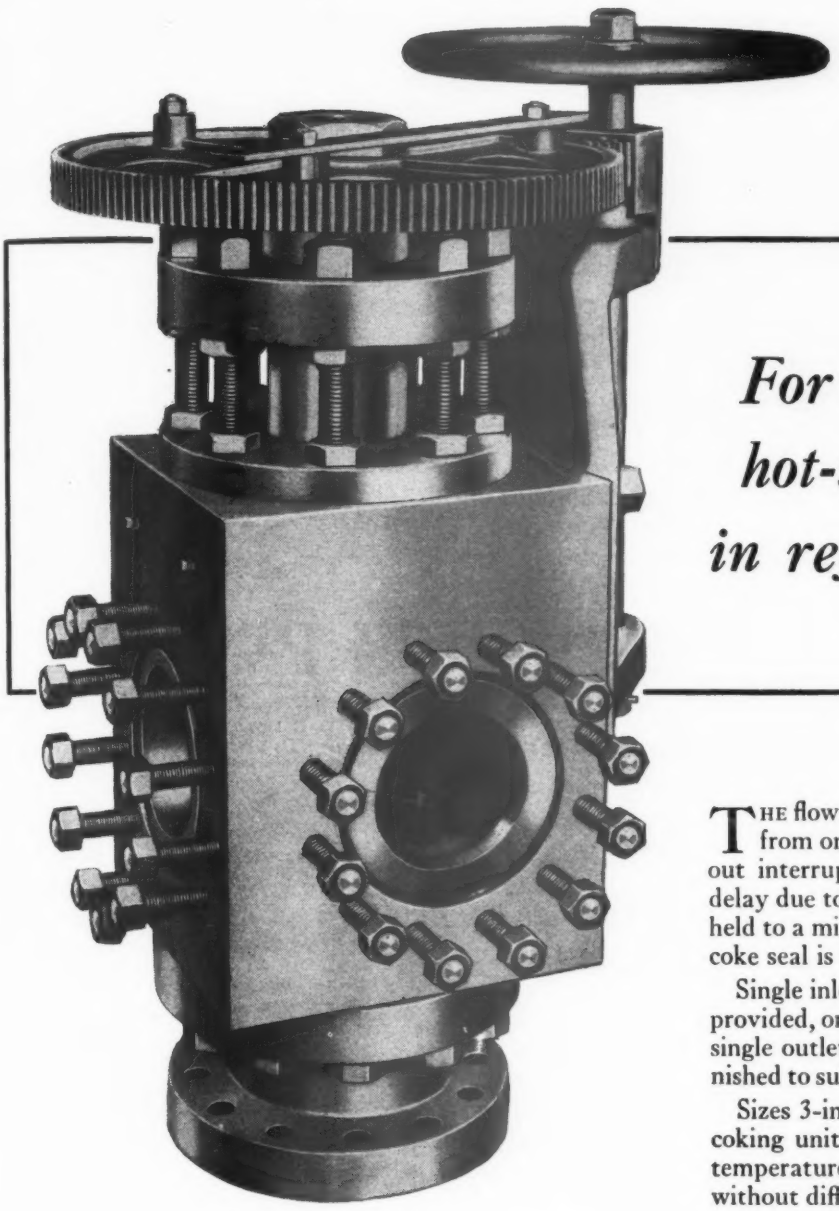
T. Ellwood Webster, president of Catalytic Construction Company and vice president of Houdry Process Corporation, attributed a large part of the speed on the construction job to the company's purchasing and expediting departments.

January 15, insulation of reactor column, catalyst hopper and elevator casing is in progress at right above. Inlet and outlet air duct at kiln is complete. Enclosure at top of structure protects workmen on elevator head shaft during extremely cold weather.

In addition to the erection of the TCC unit was included the work of revamping the existing facilities to tie in to the new unit, including removing tubes from the stills, dismantling and renewing trays in the crude tower, removing old foundations and hot oil pumps together with installation of new compressors, and the installation of a complete new water system.

March 18, the Leonard TCC unit, first postwar small-scale catalytic cracker, goes on stream. (Left). ★ ★ ★

Wilson-Snyder Switch Valves



For uninterrupted hot-stream control in refining processes

THE flow of hot liquids or vapors can be switched from one processing chamber to another without interruption of continuous flow and without delay due to coking up. The possibility of coking is held to a minimum. Positive and quick breakage of coke seal is easily accomplished.

Single inlet and two, three or four outlets can be provided, or, for reverse hookup, multiple inlets and single outlet. Inlet and outlet connections are furnished to suit purchaser's specifications.

Sizes 3-inch to 10-inch are in use on continuous coking units where pressures up to 600 p.s.i. and temperatures up to 1100° Fahrenheit are handled without difficulty.

For complete information send for bulletin W302.

WILSON-SNYDER are builders of pumping machinery for all types of refinery service, including high-pressure, high-temperature cracking and catalytic processes. From years of experience in building this type of machinery, they are familiar with a modern refinery's mechanical requirements.

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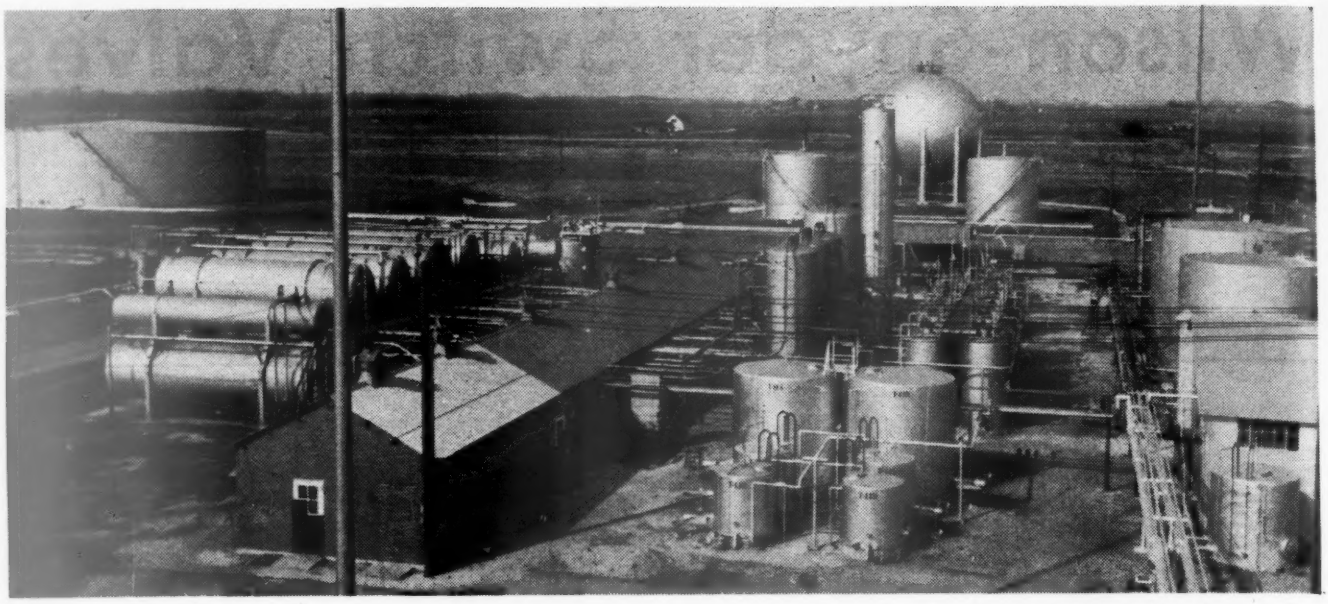
And all Oil Well Supply Company Offices

USS STEEL — UNITED STATES STEEL



Overall view of the installation.

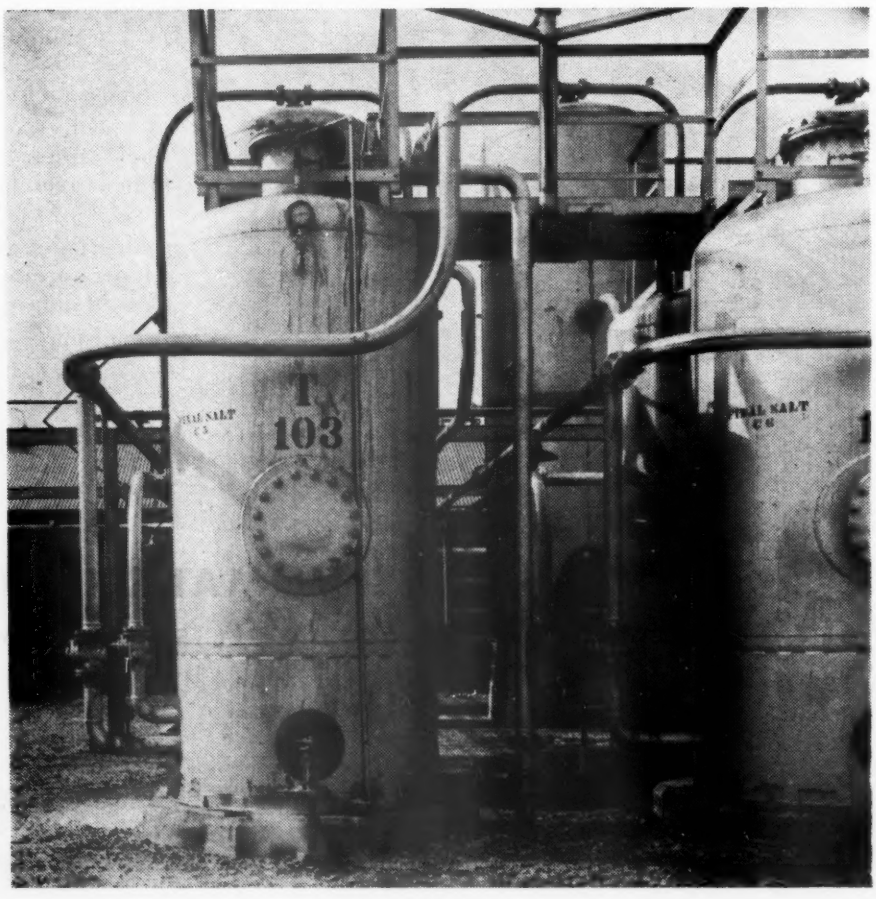
Linde copper sweetening process

By **C. T. SCHIEMAN, JR.,** *Manager,* Process Service,
Southwestern Division, The Linde Air Products Company

THE Linde copper sweetening process, sometimes called the copper chloride-oxygen method or the slurry type, has been in commercial use since 1935. It has successfully treated a wide variety of products, including straight-run and recovery gasolines, thermally and catalytically cracked gasolines, special solvents and naphthas, kerosines, and burner oils. This continuous process converts mercaptan sulphur to disulphides by means of the chemical reaction between the mercaptans and copper chloride; the copper chloride is simultaneously reactivated with pure oxygen.

EXCLUSIVE

● **Operation of the process.** The first step in the process is the removal of hydrogen sulphide, usually with a caustic wash. The sour stock is then passed through a salt filter to remove all mechanically suspended caustic; the stock then flows through a heater, which increases the temperature of the material so that the water formed in the sweetening reaction is removed. This water of reaction is directly proportional to the mercaptan content. The quantity is small, usually averaging 50 to 75 ppm,



Typical salt tank.

NO "HOT-FOOT" HERE

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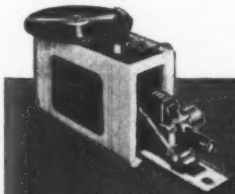
MANY a steel valve has been quickly ruined by high-temperature fluids or gases near the foot of the stuffing-box. Heat can literally "bake" the packing to the stem and the stuffing box . . . causing galling and seizing. Now OIC valve designers have solved this problem by lifting the foot of the stuffing box farther away from the hot valve body . . . to keep the packing cool and in good condition.

As you can see in the picture above, this efficient, new OIC steel valve design is as simple as A, B, C. Packing is separated from the hot valve body by a heavy, alloy-steel ring bushing (A) . . . a condensing chamber (B) . . . and a pressure-tight back-seat bushing (C). The packing stays cool . . . stays on the job to assure you long, economical, trouble-free valve service.



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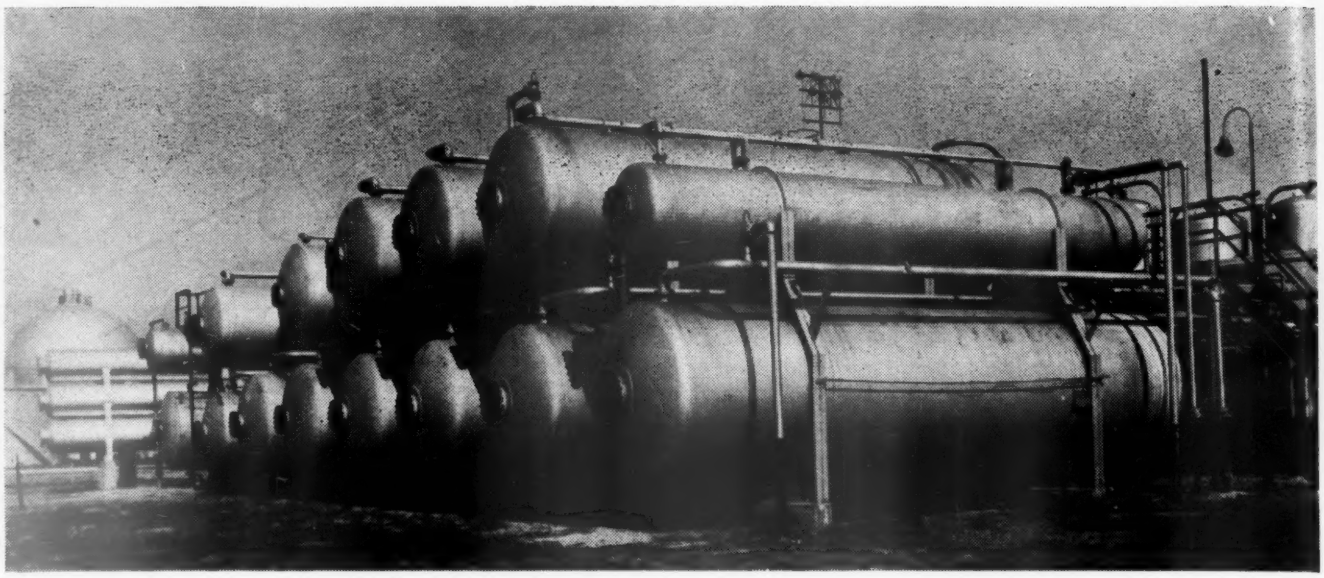
O-147-S

OIC VALVES

STEEL - IRON - BRONZE



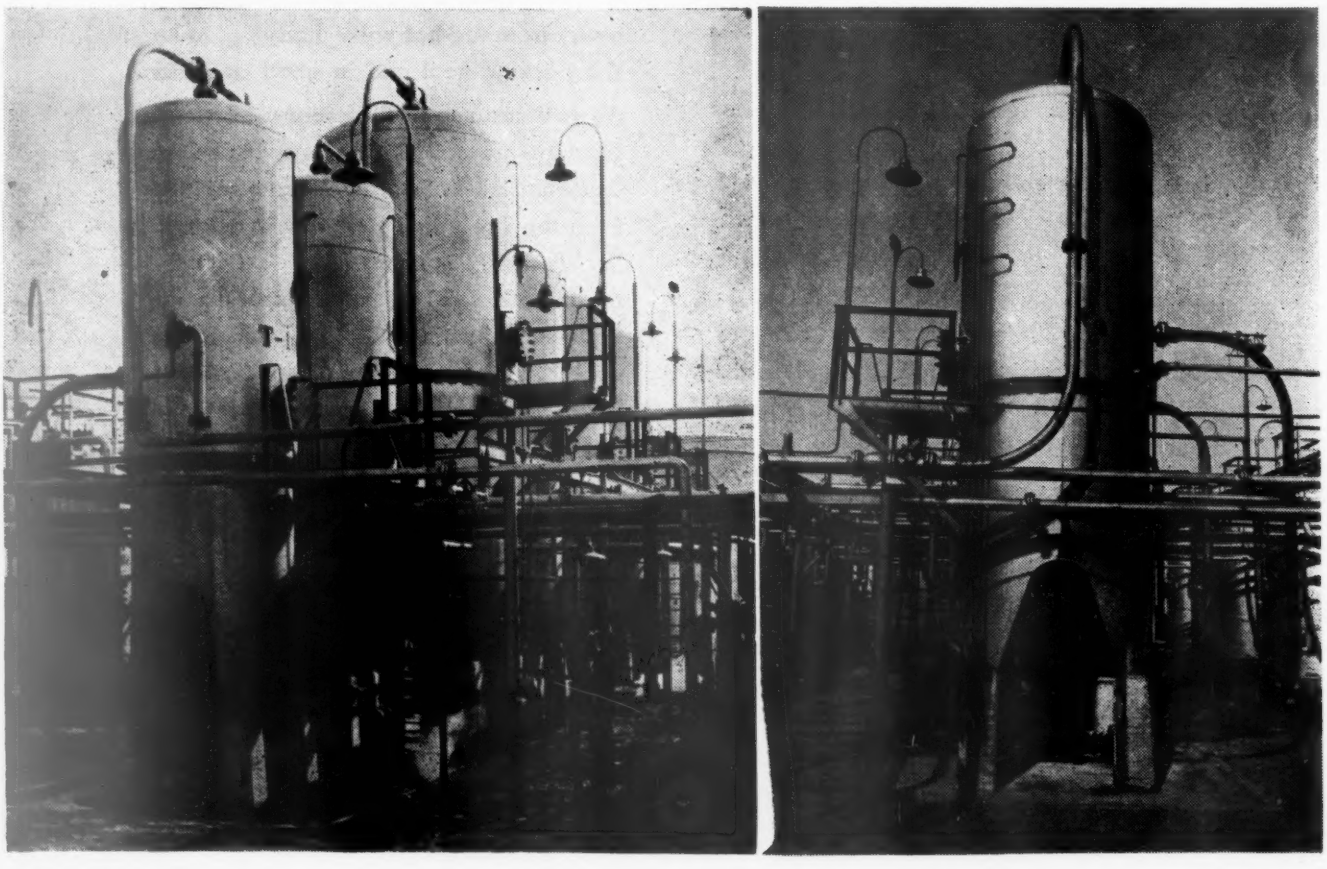
Caustic and water wash tanks.

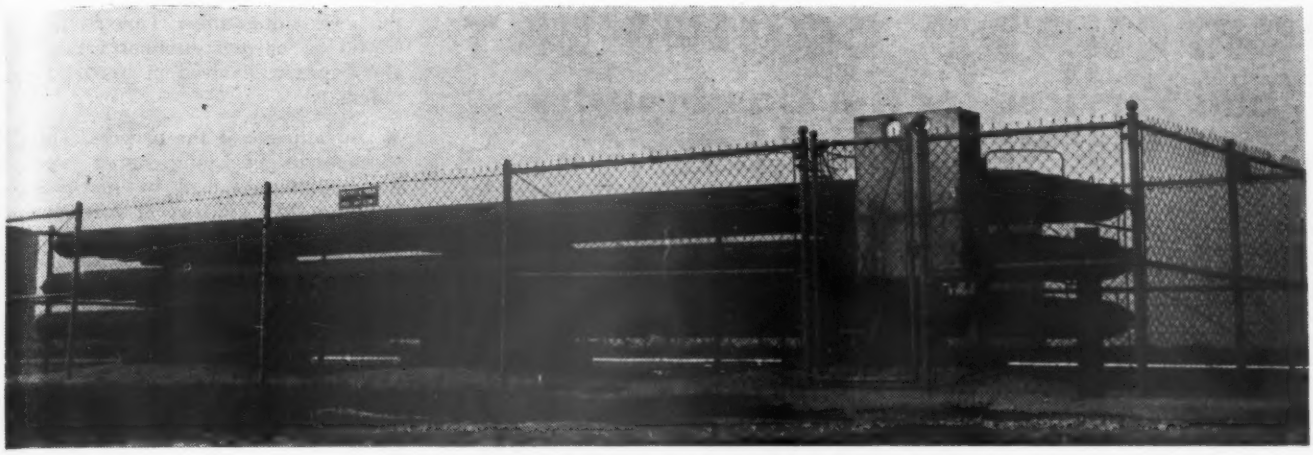
for which a temperature increase of 5 to 25 F is normally sufficient.

From the heater, the sour material flows to the suction of a centrifugal pump, which discharges the stock at a pressure of approximately 100 psig. About 10 per cent of the total stock is bypassed through a small eductor into the suction side of the pump. Pure oxygen for reactivation of the copper chloride is added continuously at the suction side of the eductor. The portion of the stock containing the oxygen is mixed with the main flow, and the oxygen becomes uniformly dispersed in the hydrocarbons. The amount of oxygen required is small—approximately 0.10 cu ft per bbl for each 0.01 per cent of mercaptan sulphur.

The sour stock containing the oxygen is discharged from the centrifugal pump through an eductor, the suction side of which is connected to the bottom of the cone of the treating tank. A mixture of 200-mesh clay and 40-60-mesh copper chloride crystals are added to the treating tank, usually by pressurizing the make-up pot. This mixture of clay, copper chloride, and sweetened stock, called the slurry, flows from the bottom of the cone of the treating tank into the eductor where it mixes with the sour stock and oxygen. The stock is immediately sweet-

Cone-bottom slurry treating tanks, left, and close-up of a treating tank showing eductor, right.





Cascade oxygen storage unit.

ened and the copper chloride is regenerated simultaneously. By maintaining a pressure drop of 60 to 70 psi across the eductor, an efficient and intimate contact of the stock, copper chloride, and oxygen is effected. This action results in minimum chemical costs and maximum quality products.

The mixture of slurry and sweetened material flows through a return line into the treating tank, where the copper chloride-clay mixture settles to the conical bottom to be recirculated. The sweet stock flows upward, is discharged from the top of the treating tank into a water wash tank and then passes through a final salt tank to remove the entrained water.

If straight-run gasolines are being sweetened, no further treatment is necessary. In the case of cracked gasolines, and sometimes kerosine, a small amount of metal deactivator is added at the outlet of the final salt tank to deactivate the minute quantities of dissolved copper compounds not removed by the water wash.

● **Typical installation.** The installation in the Socony-Vacuum Oil Company refinery at Augusta, Kansas, was placed on stream in December, 1939, and has been in continuous operation ever since, except, of course, for periods of normal refinery shutdown.

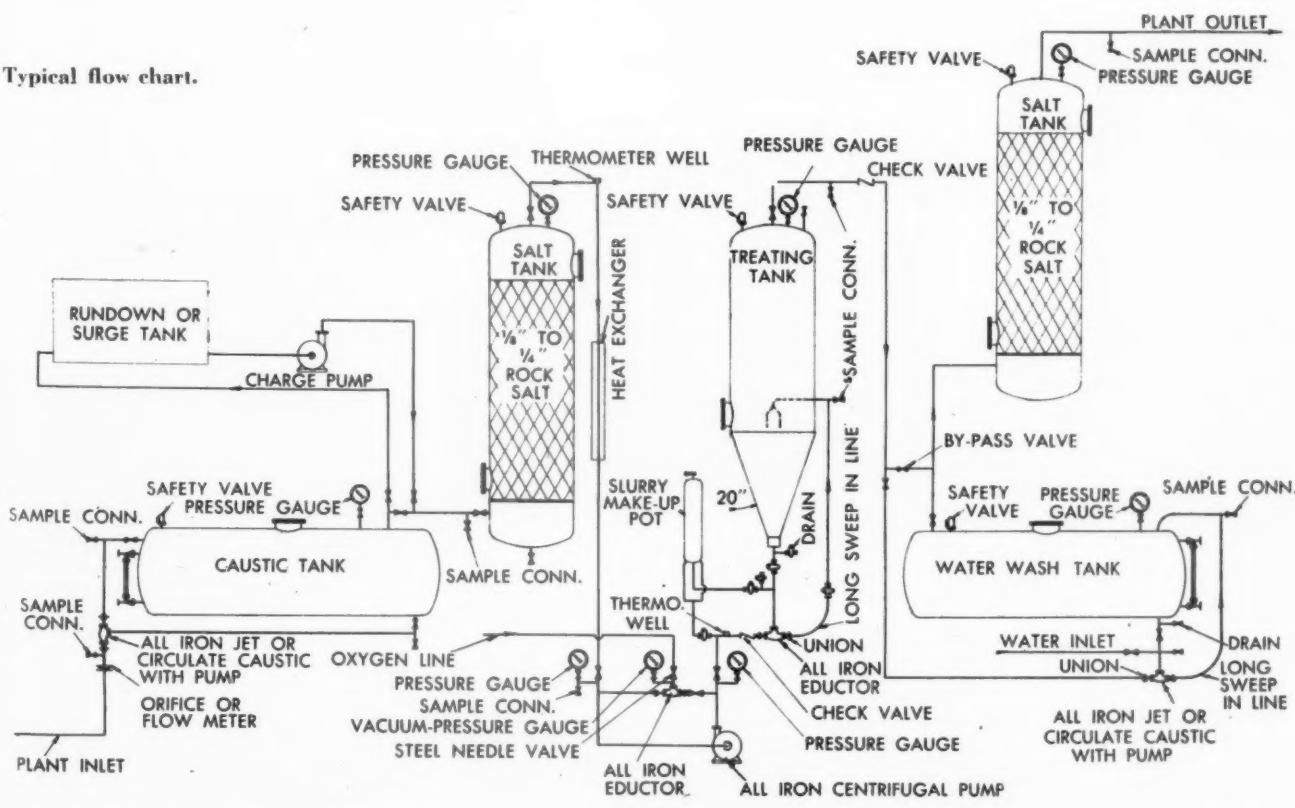
This installation consists of six separate continuous treating units with a combined capacity of approximately 25,000 bbl per 24-hr day. The illustrations show details of these sweetening units.

Two of the treating units process cracked gasoline, one sweetens straight-run gasoline, one is used for sweetening of kerosine and heating fuel, and the fifth and sixth units sweeten naphtha and recovery gasoline, respectively. The mercaptan sulphur content of these products averages approximately 0.02 per cent.

All phases of operation of these sweetening units have been entirely satisfactory during this 7-year period.

● **Oxygen supply.** The treaters are supplied with oxygen from the Cascade oxygen storage unit, shown in the illustration, which consists of a number of permanently installed special large tubes for storing gaseous oxygen. The oxygen is delivered in liquid form in special tank trucks, which include equipment for converting the liquid to gaseous oxygen and discharging it into the storage unit. From the storage unit the oxygen flows through a 1-in. diam pipe line to

Typical flow chart.



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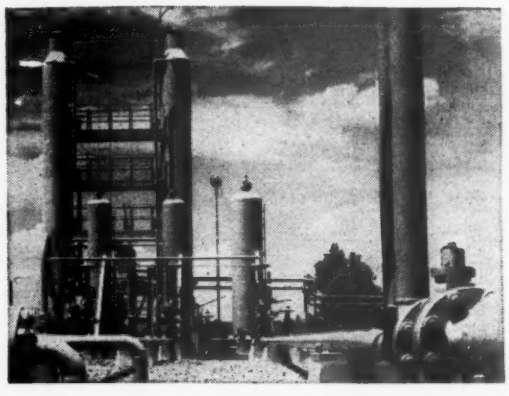
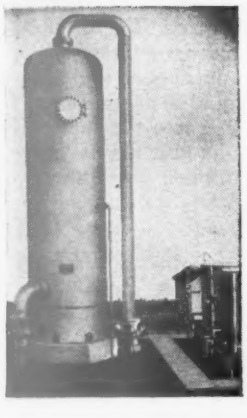


DEHYDRATION and DESULPHURIZATION UNITS
Using solid or liquid desiccants, Pritchard "Hydryers" are available as standard units in capacities as little as one c.f.m. up, for removal of moisture from liquids as well as vapors. Plants of large capacity (as pictured above) with towers alternating automatically, or "package" units (shown at left) for small-capacity service either automatic or manual regenerating. Desulphurization units are also offered from large plants down to small, portable models; fully automatic amine type for converting sour gas into sweet, usable fuel.



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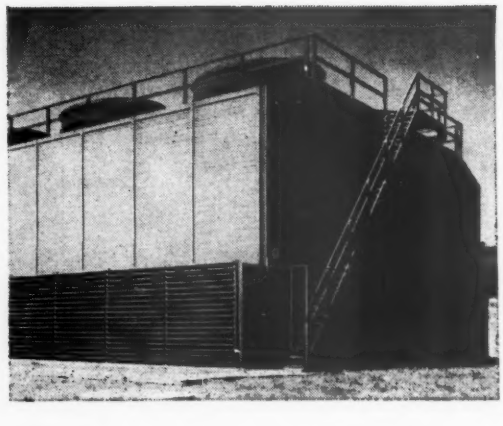

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For complete information see Pritchard pages in Refinery Catalog, Sweets Files, Chemical Engineering Catalog or write or call nearest office.

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the sweetening units. This method of supplying oxygen eliminates the time and expense involved in handling cylinders.

● **Advantages of the process.** The advantages of the Linde copper sweetening process obtained by the Socony-Vacuum Oil Company at Augusta are as follows:

1. Tetraethyl lead savings.
2. Higher quality products.
3. Lower overall operating costs.
4. Elimination of material losses.

There is no octane loss across the gasoline treaters for several reasons. First, no free sulphur is added; secondly, no alkyl polysulphides are formed, and third, there is no loss of volatile light fractions due to evaporation. In addition to the fact that there is no loss in base octane, there is no decrease in the tetraethyl lead susceptibility of the gasoline due also to the elimination of the free sulphur and alkyl polysulphides. The net result is a substantial saving in tetraethyl lead.

The elimination of free sulphur and alkyl polysulphides results in higher quality products because of better color stability, decreased potential gum, and absence of sulphur corrosion. In the case of kerosine and heating fuel, superior burning qualities are obtained with assured negative copper strip corrosion.

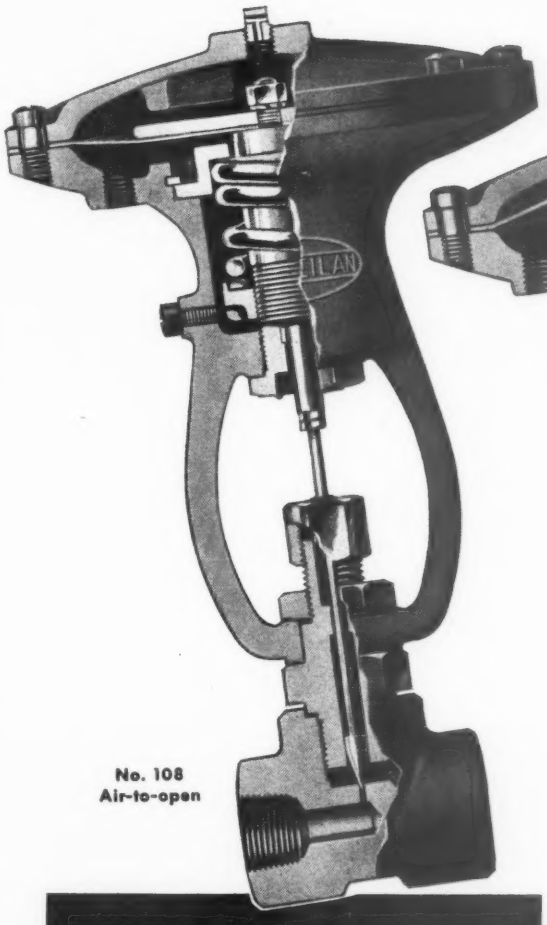
The overall operating costs of the treaters are lower for a number of reasons. The design is simple, thus requiring a minimum of equipment; inasmuch as there is no corrosion problem, standard inexpensive materials were used throughout the construction. Consequently, the first cost was less than for other types of treaters of comparable capacity, with correspondingly lower charges for amortization and interest on the investment. Chemical, steam, and power costs are low and represent a saving. Labor costs are low because the six treating units are operated by one man per shift, assisted by a service man on the daylight shift only, with supervision by the treating plant foreman, also in the daytime only. As there is no corrosion problem, maintenance charges on these units consequently have been relatively small. Material losses due to formation of sludges and emulsions, are eliminated with this treating method.

It is estimated that the investment cost of this complete treating plant at Augusta was paid off in less than two years.

This article was prepared with the cooperation of the Socony-Vacuum Oil Company. The assistance of H. L. Bedell, chief chemist of the White Eagle Division at Augusta, Kansas, is gratefully acknowledged. H. L. Bedell and his staff also assisted greatly in the early application of the Linde copper sweetening process.

The Linde copper sweetening process is licensed by The Linde Air Products Company, New York. ★ ★ ★

A Practical Approach to the Control of Extremely Small Flows



No. 108
Air-to-open

No. 107
Air-to-close

A Completely New Valve!

SPECIFICATIONS

Materials of construction:

Body ..... Type 347 stabilized 18–8 stainless steel

Plug and Seat ..... No. 6 Stellite

All other Body Parts ..... Type 316 stainless steel

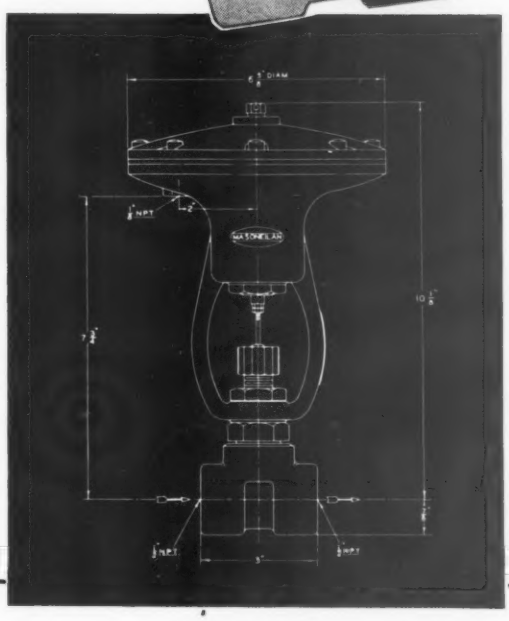
Pressure Rating ..... 6000 psi. at 100° F.
3000 psi. at 750° F.

Orifice Sizes ..... 1/16"—.0625"
3/64"—.109"

Maximum Cv ..... 1/16" orifice—.07
3/64" orifice—.20

Body Types ..... Straight through and angle body with 1/2" NPT connections with or without air fin bonnet

Superstructure ..... Air-to-open and air-to-close



- ✔ Minimum orifice for dependable, long service life.
- ✔ Stellite seat insert and plug standard trim.
- ✔ Small size combined with rugged construction simplifies installation and reduces heat loss on laboratory application.
- ✔ Special 12 sq. in. effective area diaphragm gives ample power for operation at differential pressures to 5000 psi.
- ✔ Superstructure convertible with minimum extra parts to give either air-to-open or air-to-close action.
- ✔ Superstructure designed for low lifts commensurate with orifice and plug design.

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Corrosion tests in distillation equipment

By **W. Z. FRIEND*** and **J. F. MASON, JR.***

EXCLUSIVE

THE complexity of modern refinery operation, as well as the variation in processes and crude supply from one plant to the other, makes the subject of refinery corrosion one that cannot be dealt with adequately in general terms nor in brief space. As a general rule the most satisfactory approach is to consider each refining process separately and not to confuse the subject by attempting to consider too many problems at a time. In line with this concept the writers have, in this article, limited themselves to the presentation of the results obtained from a number of plant corrosion tests in atmospheric crude distillation and in the separation, fractionation, and stabilization of the primary products from thermal cracking, processes that are common to most refineries, small or large.

The corrosion tests reported here were made with the spool-type specimen holder illustrated in Fig. 1. This method of testing is substantially in accord with A.S.T.M. Recommended Practice for Conducting Plant Corrosion Tests, A224-41.[1] Briefly, the assembly consists of previously cleaned and weighed specimens of the several metals and alloys to be tested, mounted on the spool-type holder with non-metallic parts of porcelain to separate and insulate the specimens from each other and from the metallic parts of the holder. Two similar specimens of each material were included on each spool. The completed test assemblies were fastened firmly in place in the desired test locations in operating plant equipment and allowed to remain for sufficient lengths of time to give reliable indications of corrosion behavior. Each of the test specimens used had an exposed area of 0.5 sq dm.

Upon completion of tests, the test spools were removed, dismantled, and the specimens examined, cleaned of all scale and corrosion product, and reweighed. From the weight losses, areas of specimens and duration of exposure, the corrosion rates were calculated in terms of mgs per sq dm per day, and these rates transposed to inch penetra-

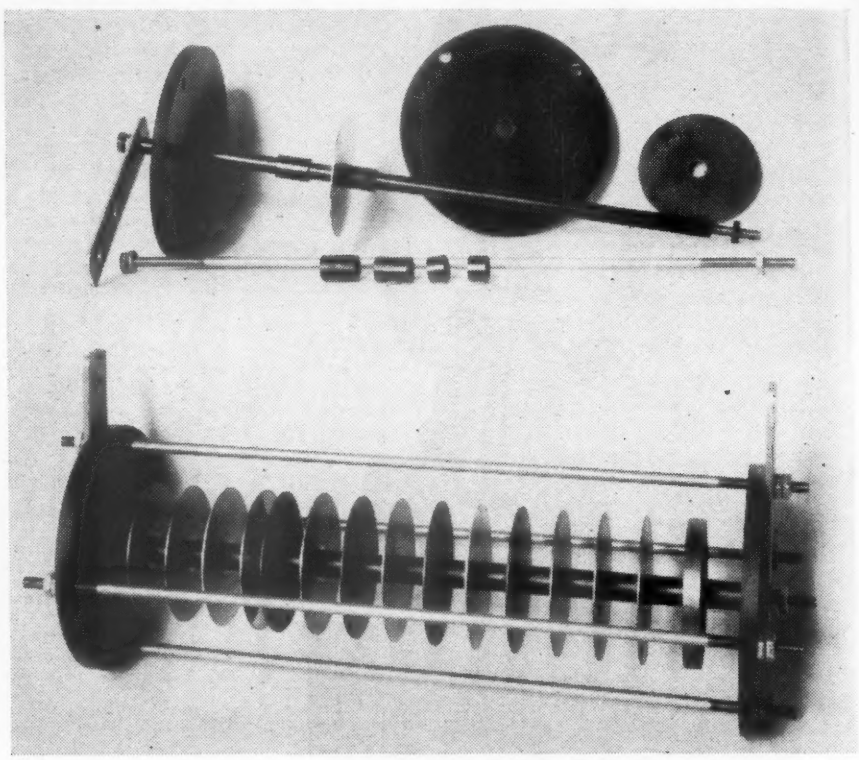

FIG. 1. Spool-type specimens holder used in plant corrosion tests.

*Development and Research Division, The International Nickel Company, Inc., New York, New York.

[1]A.S.T.M. Standards, Part I, p. 522, 1944.

TABLE 1. Nominal compositions of metals and alloys used in corrosion tests.

Material	Nickel, per cent	Copper, per cent	Chromium, per cent	Iron, per cent	Molybdenum, per cent	Silicon, per cent	Manganese, per cent	Carbon, per cent	Zinc, per cent	Other, per cent
Monel	67.0	30.0		1.4		0.1	1.0	0.15		
Nickel	99.4	0.1		0.15		0.05	0.2	0.1		
Inconel	78.5	0.2	14.0	0.35		0.5	0.3	0.1		
18-8 stainless steel (type 302)	8–10		17–19	Bal		0.75 max.	2.0 max.	0.20 max.		
18-8 stainless steel (type 304)	8–10		18–20	Bal.		0.75 max.	2.0 max.	0.08 max.		
18-8 Mo stainless steel (type 316)	10 min.		16 min.	Bal.	2–3	0.75 max.	2.0 max.	0.08 max.		
14-18 per cent Cr steel (type 430)			14–18	Bal.		1.0 max.	1.0 max.	0.12 max.		
10-14 per cent Cr steel (type 410)			10–14	Bal.		0.75 max.	0.60 max.	0.15 max.		
4-6 Cr steel (type 502)			4.6	Bal.	0.45—0.65	0.50 max.	0.5	0.15 max.		
70-30 copper-nickel	30.0	70.0								
Admiralty brass		71.0							28.0	Sn 1.0
Copper	99.9									
Silicon bronze	96.0					3.0			1.0	
Red brass	85.0								15.0	
Yellow brass	65.0								35.0	
Chemical lead	99.9									
Hastelloy A	53.0			22.0	22.0	1.0	2.0			
Hastelloy B	60.0			6.0	32.0	1.0	1.0			
Hastelloy C	51.0		17.0	6.0		1.0	1.0			W 5.0
Illium G	60.0	4.0	21.0	6.0	6.0	1.0	1.0			W 1.0
Aluminum 28	99.0 min.									
Ni-Resist (type 1)	13.5–17.5	5.5—7.5	1.75—2.50	Bal.		1.0—2.5	1.0—1.5	3.0 max.		
Ni-Resist (type 2)	18–22	0.5 max.	1.75—2.50	Bal.		1.0—2.5	0.8—1.5	3.0 max.		
5 per cent Ni steel (SAE 2512)	4.75—5.25			Bal.			0.3—0.6	0.10—0.20		
Mild steel				Bal.			0.3—0.5	0.20 max.		
Cast iron				Bal.		1.5—2.5	0.5—1.0	3.0—3.5		

Foreseeing the tremendous expansion which was bound to take place with the end of the war, FLUOR succeeded in developing and maintaining adequate sources of supply for redwood, fans, motors, gears and other Cooling Tower parts . . . without having to lower FLUOR quality standards by resorting to substitute materials.

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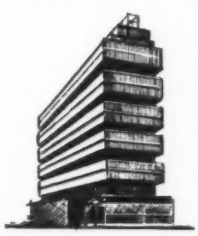

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TABLE 2. Plant corrosion tests in top of crude topping towers.

Test 1—In straight run gasoline vapor in top of tower. Sulphur content 0.99 per cent. Average temperature 220 F. Duration of test 410 days. Canadian refinery.

Test 2—In straight run gasoline vapor in top of tower containing some hydrogen chloride and hydrogen sulphide. Sulphur content 0.036 per cent. Average temperature 310 F. Duration of test 252 days. Canadian refinery.

Test 3—In straight run gasoline vapor at top of tray of tower containing some hydrogen chloride and hydrogen sulphide. Crude charged to unit is desalted. Ammonia injected into crude and into top tray reflux to control and hold pH of water taken from gasoline separator at 8.5 average. Average temperature 240 F. Duration of test 110 days. Ohio refinery.

Test 4—In straight run gasoline vapor in top of tower. Duration of test 106 days. Ohio refinery.

Test 5—In straight run gasoline vapor at top tray of tower containing some hydrogen chloride. Duration of test 90 days. Michigan refinery.

Test 6—In straight run gasoline vapor in top of tower. Average temp. 250 F. Duration of test 60 days. West Texas crude.

Test 7—In straight run gasoline vapor 10-in. above top tray of tower. 88 gal per hr sodium carbonate injected into crude feed. Average temperature 185 F. Duration of test 120 days. East Texas crude.

Material	Corrosion rate, inch penetration per year						
	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
Monel	0.0005	0.0013	0.0037	0.0030	0.0075	0.0031	0.014
Nickel	0.0002[1]	0.0016	0.0021[5]	0.0027[5]	0.0069	0.0057[9]	0.011
Inconel	0.0002	0.0012	0.0014	0.0020	..	0.017[8]	0.035
18-8 stainless steel (type 302)	†0.0001[2]	0.0008[4]	..	0.0002[3]	0.025	*	0.029
18-8 stainless steel (type 304)	..	..	..	0.0002[5]	..	*	0.029
18-8 Mo stainless steel (type 316)	..	..	0.0004[6]	..	..	0.053[10]	0.025
13 per cent Cr steel (type 410)	0.0003[3]	0.0036	0.0074[7]	0.0078	..	..	0.051
4-6 per cent Cr steel (type 502)	0.0005	0.0049	..	..	..	..	..
25 Cr—12 Ni (type 309)	..	..	0.0014[4]	..	..	..	..
Hastelloy A	0.0001	0.0011	..	..	..	..	..
Aluminum 28	0.0003	0.0051	..	..	..	*	..
Admiralty metal	0.0007	0.0033	..	..	0.022	..	0.087
70-30 copper-nickel	..	..	0.010	..	..	..	0.017
Copper	*	*	..	..	..	..	..
Silicon bronze	*	0.0077	..	..	..	..	..
Red brass	*	0.0072	..	..	0.033	..	..
Yellow brass	..	..	..	..	0.024	..	..
Chemical lead	0.0007	0.0034	..	..	..	*	..
5 per cent nickel steel (SAE 2512)	..	..	..	..	..	*	..
Mild steel	0.0031	0.019	0.016	0.0093	0.049	*	0.091
Ni-Resist (type I)	0.0004	0.009	..	0.0032	..	0.051	..
Cast iron	0.0007	0.020	..	0.012	..	0.181[11]	..

†Less than.
*Specimens completely destroyed during test. Original thickness 0.031-in.
[1]Local attack in the form of pitting to a maximum depth of 0.010-in.
[2]Local attack in the form of pitting to a maximum depth of 0.018-in.
[3]Local attack in the form of pitting to a maximum depth of 0.008-in.
[4]Local attack in the form of pitting to a maximum depth of 0.012-in.
[5]Local attack in the form of pitting to a maximum depth of 0.009-in.
[6]Local attack in the form of pitting to a maximum depth of 0.011-in.
[7]Specimens perforated during test. Original thickness of 0.031-in.
[8]Local attack in the form of pitting to a maximum depth of 0.016-in.
[9]Local attack in the form of pitting to a maximum depth of 0.013-in.
[10]Local attack.
[11]Graphitized.

TABLE 3. Plant corrosion tests in straight-run gasoline from crude topping towers.

Test 1—Immersed in 62° API gasoline distillate in reflux drum. Ammonia added to system to pH 7-8. Average temperature 100 F. Duration of test 180 days. Ohio refinery—Illinois crude.

Test 2—In vapor and condensate in vapor line preceding secondary condenser. Duration of test 81 days. Ohio refinery.

Test 3—In storage of untreated straight run gasoline. Temperature 44-84 F. Duration of test 96 days. Kansas refinery.
Location A—Immersed in liquid gasoline containing 0.02-0.03 gm/1 H_2S.
Location B—In gasoline vapor mixed with 50-60 per cent air. Mixture contained 10 to 60 grains H_2S per 100 cu. ft

Test 4—In vapor of untreated straight-run gasoline in vapor line of first condenser. Average temperature 425 F. Duration of test 290 days. (Plant in operation approximately one-third of total elapsed time.) Kentucky refinery.

Test 5—In straight run gasoline vapor and condensate in shell side of condenser on unit handling sweet crudes. Average temperature 350 F. Duration of test 365 days. Louisiana refinery.

Test 6—In vapor section of storage tank handling untreated straight run gasoline. Temperature 50-110 F. Duration of test 195 days. Pennsylvania refinery.

Material	Corrosion rate, inch penetration per year					
	Test 1	Test 2	Test 3		Test 4	Test 5	Test 6
			Location A	Location B			
Monel	0.0015	0.0045	0.0007	0.0024	0.0004	0.0003	0.0014
Nickel	0.0008[1]	0.0030[4]	0.0012[8]	0.0023	0.0007	0.0003	0.0009
Inconel	0.0002[1]	0.0047[3]	†0.0001	†0.0001	0.0015[8]	†0.0001	†0.0001
18-8 stainless steel (type 302)	..	0.0031[6]	†0.0001	..	..	†0.0001	..
18-8 stainless steel (type 304)	0.0001[2]	..	†0.0001	†0.0001	0.0001[11]	†0.0001	..
18-8 Mo stainless steel (type 316)	0.0001	..	..	..	..	..	..
17-19 per cent Cr steel (type 430)	..	..	..	..	..	†0.0001	..
4-6 per cent Cr steel (type 502)	..	..	0.0011[8]	0.0012[8]	..	0.0002	..
Aluminum 28	..	..	0.0002[5]	0.0001[10]	..	..	..
Admiralty metal	..	0.012	0.0025[9]	0.0010	0.0037	0.0003	0.0018
70-30 copper nickel	..	0.009[2]	0.0007	0.0028	0.0009	0.0004	0.0014
Copper	..	..	..	..	..	..	0.0088
Red brass	..	0.019[7]	..	..	..	0.0003	..
Chemical lead	..	..	..	..	..	0.0008	..
5 per cent nickel steel (SAE 2512)	..	..	..	..	..	..	0.0046
Mild steel	0.0078[3]	..	0.0020	0.0055	0.012[7]	0.0009	0.0082
Ni-Resist (type I)	0.0014	..	0.0006	0.0007	0.0063	†0.0001	..
Ni-Resist (type II)	0.0013	..	..	..	..	..	..
3 per cent nickel cast iron	0.0052	..	..	..	..	..	..
Cast iron	0.0066	..	0.0034	0.0026	0.011	0.0004	..

†Less than.
[1]Local attack in the form of pitting to a maximum depth of 0.004-in.
[2]Local attack in the form of pitting to a maximum depth of 0.005-in.
[3]Local attack in the form of pitting to a maximum depth of 0.011-in.
[4]Local attack in the form of pitting to a maximum depth of 0.009-in.
[5]Local attack in the form of pitting to a maximum depth of 0.007-in.
[6]Local attack in the form of pitting to a maximum depth of 0.025-in.
[7]Specimens perforated during test. Original thickness 0.031-in.
[8]Local attack in the form of pitting to a maximum depth of 0.008-in.
[9]to a maximum depth of 0.017-in.
[10]Local attack in the form of pitting to a maximum depth of 0.006-in.
[11]to a maximum depth of 0.016-in.

tion per year (ipy), the unit used in the accompanying tables. This unit is based upon the assumption of uniform corrosion in practice from one side of the metal only. The rate shown for each material is the average of the two specimens included in each test. In addition, each specimen was examined for cracking, pitting, and other forms of local attack. Where pitting or local attack occurred, depth of the five or ten deepest pits was measured microscopically or with a depth gauge. In the accompanying tables maximum depth of pitting is reported, where it occurred.

Approximate compositions of the metals and alloys included in one or more of these tests are shown in Table 1.

● **Atmospheric crude distillation.** Corrosion in atmospheric crude distillation arises chiefly from two sources: (1) From hydrochloric acid, either formed by hydrolysis of chloride salts, especially calcium and magnesium chloride, entrained in the crudes, or added by the acidizing of wells, and (2) from hydrogen sulphide and other sulphur compounds present in the crudes. Corrosion from both of these sources appears to have been increasing in recent years due to the use of crudes with higher salt and sulphur contents. Despite the customary practice of settling the salt water from crudes, and in some cases the use of special desalting processes, there still appears to be enough salt water dispersed in such crudes to result in the formation of an acid condition. Corrosion is mitigated in some cases by injection of ammonia into the distillation system to neutralize part of the acid, but experience would indicate that this frequently is not an adequate solution to the problem.

It is probable that with salty charging stocks, maximum hydrolysis of magnesium and calcium chlorides occurs in the hottest region at the bottom of distillation towers; however, maximum acid corrosion occurs in the top portion of such towers, in reflux and distillate condensers, coolers, and accumulators, and in reflux and run-down lines, where temperatures are low enough for an aqueous acid phase to condense. Maximum corrosion by sulphur compounds will, on the other hand, occur in the higher temperature ranges in the bottom portions of distillation towers and in crude heaters. As the alloys most resistant to acid corrosion frequently are not resistant to high temperature sulphur attack, it is common practice to line the top and bottom portions of distillation towers with different materials to obtain most favorable performance.

Table 2 gives the results of corrosion tests on or above the top plate of atmospheric crude distillation towers in seven different refineries in a number of different geographical locations. Unfortunately, it was not possible in all cases to obtain as complete information as was desired concerning the source and previous treatment of the charging crudes. It is apparent, however, from the corrosion rates that a number of them were salty

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TABLE 4. Plant corrosion tests in water layer in reflux water separators.

Test 1—Immersed in water layer containing some hydrogen chloride and hydrogen sulphide. Average temperature 120 F. Duration of test 414 days. Plant 1.

Test 2—Immersed in water layer containing some hydrogen sulphide. Neutralization number 0.07. Average temperature 110 F. Duration of test 290 days. Plant 2.

Test 3—Immersed in water layer containing traces of hydrogen chloride and hydrogen sulphide. pH maintained as close to 7.0 as possible. Average temperature 90 F. Duration of test 366 days. Plant 4.

Material	Corrosion rate, inch penetration per year — Test 1, plant 1	Test 2, plant 2	Test 3, plant 4
Monel	0.0019	0.0004	0.0007
Nickel	0.0023	0.0002	0.0012
Inconel	0.0002[1]	†0.0001	†0.0001
18-8 stainless steel (type 302)	0.0001[2]	†0.0001	†0.0001
13 per cent Cr steel (type 410)	0.0009[3]	0.0002	0.0001[8]
4-6 per cent Cr steel (type 502)	0.0061[4]	0.0033	0.0014
Hastelloy B	0.0011	0.0002	0.0010
Aluminum 2S	0.0018[5]	*	0.0003[9]
Admiralty metal	0.0018	0.0004	0.0009
Copper	*	0.013	0.0014
Silicon bronze	0.012	0.013	0.0012
Red Brass	0.0087	0.011	0.0012
Chemical lead	*	0.0001[7]	0.0009[10]
Mild steel	0.018	0.0074	0.0073
Ni-Resist (type 1)	0.0028	0.0008	0.0013
Cast iron	0.0051	0.004	0.0072

†Less than.
*Specimens completely corroded away during test. Original thickness 0.031-in.

Local attack in form of pitting
[1]To maximum depth of 0.003-in.
[2]To maximum depth of 0.015-in.
[3]To maximum depth of 0.010-in.
[4]To maximum depth of 0.018-in.
[5]To maximum depth of 0.017-in.
[6]Perforated by pitting. Original thickness of specimens 0.031-in.
Local attack in form of pitting
[7]To maximum depth of 0.005-in.
[8]To maximum depth of 0.020-in.
[9]To maximum depth of 0.016-in.
[10]To maximum depth of 0.022-in.

TABLE 5. Plant corrosion tests in bottom of crude topping towers.

Test 1—Immersed in topped crude of 18° API containing salt and sulphur. Sulphur varied between 1.39 per cent and 0.82 per cent. Neutralization number 0.60 to 0.20. Average temperature 625 F. Duration of test 366 days. Canadian refinery.

Test 2—Immersed in reduced crude of 28.1 API containing 0.58 per cent total sulphur. Average temperature 525 F. Duration of test 290 days. Canadian refinery.

Test 3—Immersed in crude in continuous still. Average temperature 835 F. Duration of test 70 days. West Texas crude.

Test 4—At bottom of No. 2 crude fractionating tower approximately 5-in. above tray No. 38 near the overflow side. Average temperature 700 F. Duration of test 120 days. East Texas crude. 88 gal per hr. Na_2CO_3 injected into crude feed.

Material	Corrosion rate, inch penetration per year — Test 1	Test 2	Test 3	Test 4
Monel	0.0083	0.016	..	0.17
Nickel	0.0077	*	..	..
Inconel	†0.0001	0.0002	..	0.0002
18-8 stainless steel (type 302)	0.0001	†0.0001	0.024	†0.0001
18-8 stainless steel (type 304)	..	..	..	0.0001
18-8 Mo stainless steel (type 316)	..	..	..	†0.0001
13 per cent Cr steel (type 410)	0.0001	0.0013‡	..	0.0014
4-6 per cent Cr steel (type 502)	0.0002	0.0061	0.040	..
Hastelloy A	0.0002	0.0001	..	..
Aluminum 2S	0.0001	†0.0001	..	..
Admiralty metal	0.0024	0.0002	..	..
Copper	*	*	..	..
Silicon bronze	0.010	*	..	..
Red brass	0.014	*	..	..
Chemical lead	*	*	..	..
Mild steel	0.0025	0.0074	0.23	0.030
Nitralloy	..	..	0.040	..
Ni-Resist (type I)	0.0002	0.0033	..	..
Cast iron	0.0021	0.0061	..	..

†Less than.
*Specimens completely corroded away during test. Original thickness 0.031-in.
‡Local attack in the form of pitting to a maximum depth of 0.004-in.

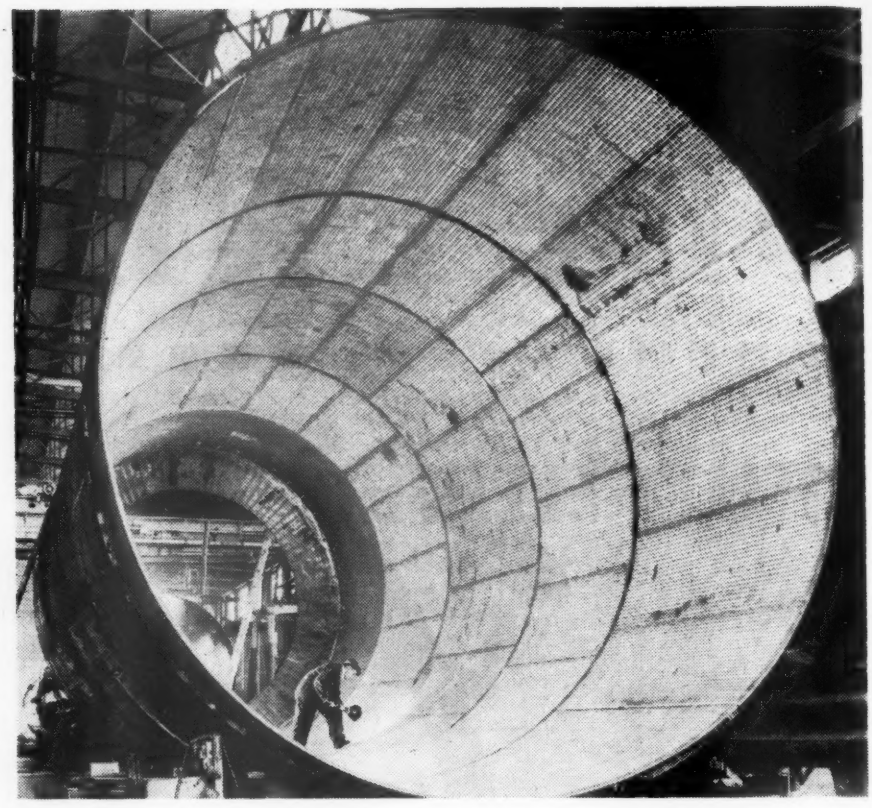


FIG. 2. Crude fractionating tower. Bottom section lined with 18-8 stainless steel and top section with Monel.

crudes, and that hydrochloric acid was present as a corrosive agent. These are characterized principally by the pitting or corrosive attack that occurs on the stainless steels as well as by the more severe corrosion of mild steel. It will be noted that Monel was, in general, the most resistant material from the standpoint of resistance to both general corrosion and pitting. It has been used to a considerable extent as a lining or as a Monel-clad steel shell for upper tower sections, reflux and distillate accumulators and condenser shells, and in some cases for reflux and run-down lines. It is also used for fabricated bubble caps, plates, and fittings in upper tower sections.

In further connection with the handling of straight-run gasoline and reflux from crude topping, the corrosion test results in Table 3 are presented. These tests also were made in a number of different refineries in the untreated gasoline distilled from a variety of crudes. Conditions involving the greatest amount of acidity are associated with Tests 1, 2, and 4, where corrosion of mild steel was greatest and the most significant pitting of chromium-containing alloys occurred. The same trend will be noted in Table 4, which gives the results of tests in the condensed water layer in the bottom of distillate-water separators. In this case Test 1 involved exposure to acid conditions.

For the tubes of gasoline condensers and coolers it is customary to use either Admiralty brass, copper-nickel alloys containing 10, 20, or 30 per cent nickel, or Monel, depending upon the degree of acidity of the condensate and condition of the cooling water. Under some conditions, Admiralty brass is subject to dezincification. Typical practice appears to have been to start out using Admiralty and then change to copper-nickel or Monel if the original installation did not prove to be satisfactory.

Note should be taken of the fact that the Ni-Resist austenitic cast-iron alloys, Type 1 (containing 14 per cent nickel and 6 per cent copper) and Type 2 (containing 20 per cent nickel) are considerably more resistant than cast-iron under dilute acid conditions, and these materials are used for reflux and distillate pumps, valves, and fittings, frequently with wrought parts and trim of Monel.

Reference was made previously to the fact that different materials are required for the lining of bottom portions of distillation towers than for top portions. The results of a number of corrosion tests in the bottom of such towers are given in Table 5. Monel and nickel are subject to severe general and intergranular attack by sulphur compounds at temperatures much in excess of 500 F. The austenitic stainless steels, including Types 302, 304, and 316 are, on the other hand, highly resistant to the higher temperature sulphur conditions and consequently make the most satisfactory materials for linings or clad-

TABLE 6. Plant corrosion tests in vapor separator thermal cracking of gas oil.

In bottom of separator tower
Test 1—In residuum from cracked gas oil and vapor. Total sulphur content 0.60 to 0.70 per cent. Average temperature 780 F. Duration of test 112 days (Plant 1).
Test 2—In residuum from cracked gas oil and vapor. Total sulphur content 1.0 per cent. Average temperature 780 F. Duration of test 74 days (Plant 2).
Test 3—In residuum from cracked gas oil and vapor. Average temperature 780 F. Duration of test 58 days. (Plant 3)
Test 4—In residuum from cracked gas oil and vapor. Sulphur content 0.56 per cent to 1.25 per cent. Average temperature 770 F. Duration of test 366 days (Plant 4).

In top of separator tower
Test 5—In vapor from gas oil residuum. Sulphur content of oil condensed from these vapors was about 0.22 per cent. Average temperature 753 F. Duration of test 112 days (Plant 1).
Test 6—In vapor from gas oil residuum. Sulphur content 0.5 per cent. Average temperature 760 F. Duration of test 252 days (Plant 3).
Test 7—In vapor from gas oil residuum. Sulphur content 0.5 per cent. Average temperature 725 F. Duration of test 366 days (Plant 4).

At tower feed inlet
Test 8—In cracked gas oil residuum and vapor between baffles near tower inlet. Sulphur content 0.75 per cent. Average temperature 810 F. Duration of test 75 days (Plant 2).

Material	Corrosion rate. inch penetration per year							
	In bottom of evaporator tower				In top of evaporator tower			At tower feed inlet
	Test 1 Plant 1	Test 2 Plant 2	Test 3 Plant 3	Test 4** Plant 4	Test 5 Plant 1	Test 6** Plant 3	Test 7 Plant 4	Test 8 Plant 2
Monel	*	0.013	0.037	*	*	*	*	0.021
Nickel	*	*	0.032	*	*	*	*	0.066
Inconel	0.0012	0.0015	0.0041	0.0012	0.0012	0.0012	0.0005	0.0019
18-18 stainless steel (type 302)	0.0006	0.0010	0.0010	0.0006	0.0001	0.0003	0.0008	0.0008
18-8 Mo stainless steel (type 316)	0.0005	0.0009	0.0014	0.0004	0.0001	0.0006	0.0006	0.0009
13 per cent Cr steel (type 410)	0.0022	0.0028	0.0022	0.0018	0.0003	0.0005	0.0006	0.0018
4-6 per cent Cr steel (type 502)	0.0023	0.0016	0.014	0.0020	0.0028	0.0028	0.0011	0.0027
Hastelloy A	0.0002	0.0003	0.0019	0.0004	0.0001	0.0005	0.0001	0.0006
Aluminum 2S	*	†0.0001	0.011	†0.0001	†0.0001	†0.0001	†0.0001	0.0001
Silicon bronze	0.100§	0.036§	0.020§	0.066	0.080	*	*	0.036
Mild steel	0.048	0.095	‡	0.0075	‡	0.012	0.027	0.051
Ni-Resist (type 1)	††	0.005	0.011	0.0067	0.018	0.006	0.038	0.008
Cast iron	0.033	0.013	0.040	0.0097	0.066	0.020	*	0.051

**Specimens on these spools were coked up.
†Less than.
Specimens completely destroyed during test. *Original thickness 0.031-in. ††Original thickness 0.187-in. ‡Original thickness 0.062-in.
§Specimens perforated during test. Original thickness 0.031-in.

TABLE 7. Plant corrosion tests in fractionation of pressure distillate from thermal cracking of gas oil.

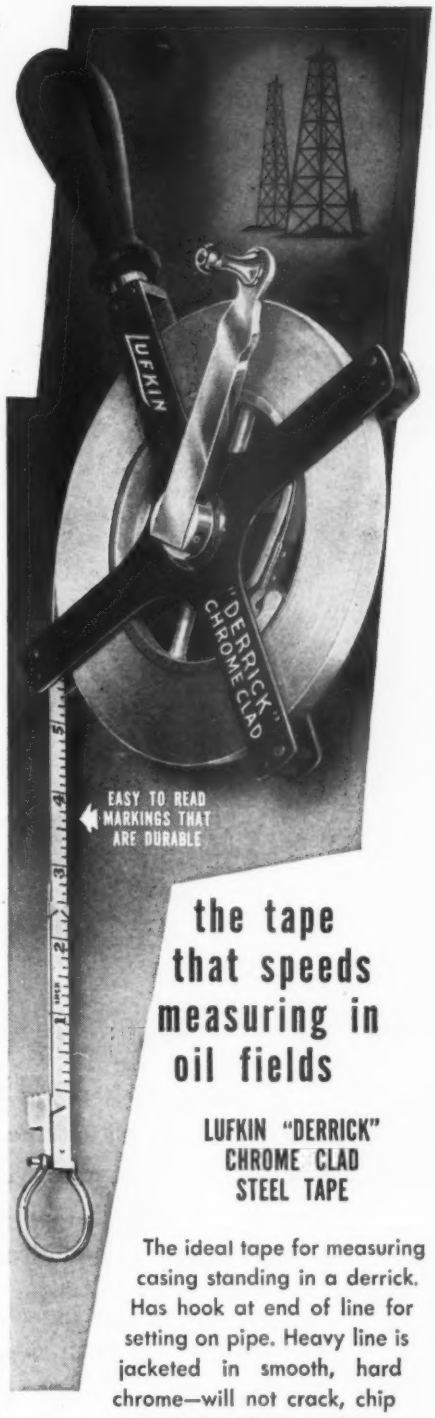
In liquid at bottom of pressure distillate bubble tower
Test 1—In gas oil with sulphur content of 0.25 per cent. Average temperature 675 F. Duration of test 235 days. (Plant 1.)
Test 2—In gas oil with sulphur content of 0.75 per cent. Average temperature 690 F. Duration of test 75 days. (Plant 2.)
Test 3—In gas cil with sulphur content of 0.70 per cent. Average temperature 590 F. Duration of test 122 days. (Plant 3.)
Test 4—In gas oil with sulphur content of 0.21 per cent. Average temperature 715 F. Duration of test 197 days. (Plant 4.)
In vapor above inlet of pressure distillate bubble tower
Test 5—In vapor from gas oil. Average temperature 700 F. Duration of test 112 days. (Plant 1.)
Test 6—In vapor from gas oil containing 0.6 per cent sulphur. Average temp. 590 F. Duration 122 days. (Plant 3.)

Material	Corrosion rate, inch penetration per year					
	In liquid at bottom of pressure distillate bubble tower				In vapor at top of pressure distillate bubble tower	
	Test 1 Plant 1	Text 2 Plant 2	Test 3 Plant 3	Test 4 Plant 4	Test 5 Plant 1	Test 6 Plant 3
Monel	*	*	0.022	*	*	*
Nickel	*	*	*	*	*	*
Inconel	0.0006	0.0022	0.0017	0.0008	0.0005	0.0015
18-8 stainless steel (type 302)	0.0001	0.0003	0.0001	0.0001	0.0001	0.0004
13 per cent Cr steel (type 410)	0.0009	0.0015	0.0010	0.0006	0.0004	0.0015
4-6 per cent Cr steel (type 502)	0.0026	0.017	0.0006	0.0033	0.0024	0.0051
Hastelloy A	0.0002	0.0003	0.0004	0.0002	0.0002[1]	0.0004
Aluminum 2S	0.0002	0.0001	0.0001	*	0.0007	0.0063
Red brass	*	*	*	*	*	*
Admiralty metal	0.0024	0.0059	0.0021	0.0077	0.0019	0.0016
Silicon bronze	*	*	*	*	0.038[2]	*
Mild steel	0.038	0.144	0.013	‡	0.085[2]	0.018
Ni-Resist (type 1)	0.019	0.075	0.012	0.058	0.039	0.025
Cast iron	0.067	0.096	0.011	0.052	0.038	0.024

Specimens completely destroyed during test. *Original thickness 0.031-in. ‡Original thickness 0.062-in.
[1]Local attack is the form of pitting to a maximum depth of 0.004-in.
Specimens perforated during test. [2]Original thickness 0.031-in. [3]Original thickness 0.062-in.

steel shells of bottom tower sections as well as for fabricated bubble caps, trays, and fittings in bottom sections. Care should be used to eliminate excessive working stresses from such fabricated parts by stress-relief anneal where there is a possibility that some acid condensation might occur, for the stainless steels are subject to stress-corrosion cracking under hot acid chloride conditions. Fig. 2 illustrates a fractionation tower having the bottom section lined with 18-8 stainless steel and the top section lined with Monel.

● **Distillation of products from thermal cracking.** The corrosive effects of sulphur compounds are particularly pronounced at the high temperatures en-



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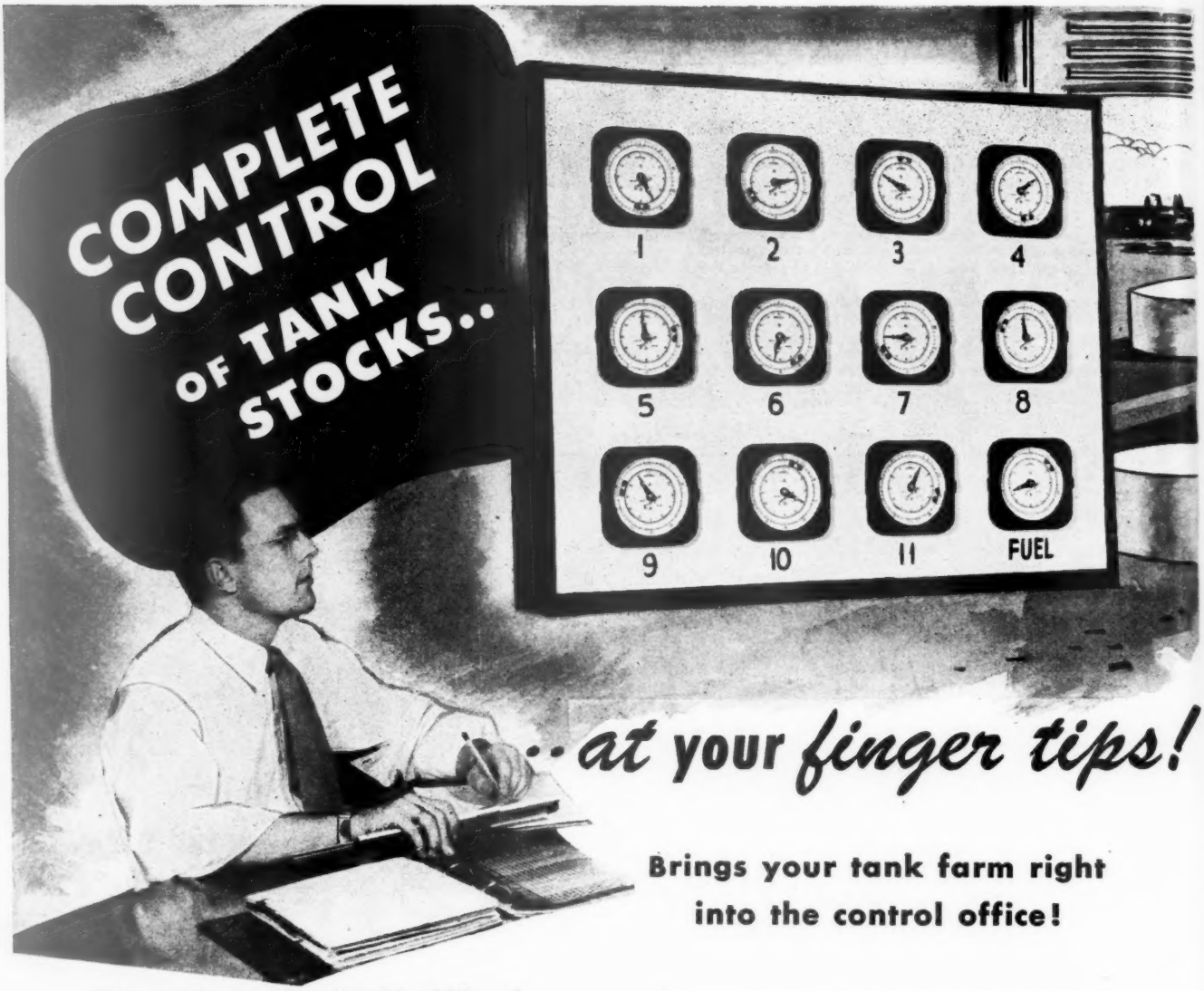

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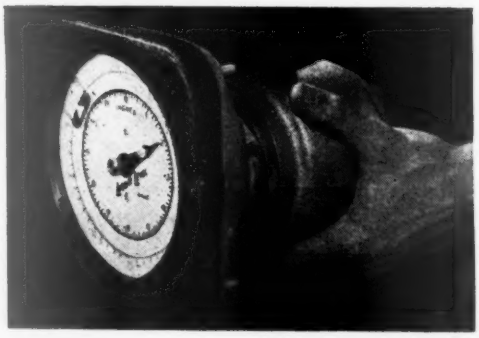

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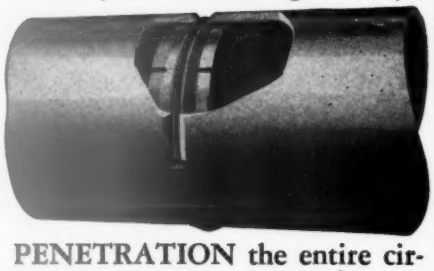

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TABLE 8. Plant corrosion tests in fractionation of cracked gasoline. Duration of tests—318 days.

Test 1—In vapor in bottom of crude stabilizer. Average temperature 375 F.
Test 2—In liquid in bottom of crude stabilizer. Average temperature 325 F.
Test 3—In upper section of crude stabilizer above top tray. Exposed to reflux. Average temperature 150 F.
Test 4—In reflux accumulator, 5 ft. above bottom. Average temperature 110 F.
Test 5—In top of fractionating tower in vapor distillate (56° API) at a pressure of 375 psi. Average temperature 375 F.
Test 6—In liquid condensate (105° API) in bottom of absorber tower at a pressure of 315 psi. Average temperature 100 F.

Material	Corrosion rate, inch penetration per year					
	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Monel	0.004	0.003	0.001	0.0004	0.003	0.0003
Nickel	0.004	0.003	0.001	0.0007[7]	0.004	..
Inconel	0.005	0.001	0.0002	†0.0001[8]	0.0004	†0.0001[11]
18-8 stainless steel (type 302)	..	0.001[1]	0.0002[5]	..	0.0004[10]	0.0003[6]
18-8 stainless steel (type 304)	..	0.001[2]	0.0002[6]	..	0.0004[5]	0.0011[5]
18-8 Mo stainless steel (type 316)	..	†0.001[3]	†0.0001[6]	..	†0.0001[7]	..
4-6 per cent Cr steel (type 502)	..	..	..	..	..	0.004
Hastelloy C	..	†0.001	†0.0001	..	..	..
Illium G	..	†0.001	†0.0001	..	..	..
Aluminum 28	..	0.004[4]	0.0005[4]	†0.0001[9]	0.0008	..
70-30 copper-nickel	..	..	..	0.010	..	..
Admiralty metal	0.008	..	..	0.001	..	..
Mild steel	0.021	..	..	0.002	0.005	0.004
Ni-Resist (type I)	0.002	0.001	0.0008	0.002	0.001	0.001
Cast iron	0.006	0.003	0.002	0.003	0.002	0.003

†Less than.
Local attack in the form of pitting [1]To a maximum depth of 0.015-in. [2]To a maximum depth of 0.020-in. [3]To a maximum depth of 0.104-in.
[4]Specimens perforated during test. Original thickness 0.031-in.
Local attack in the form of pitting [5]To a maximum depth of 0.010-in; [6]To a maximum depth of 0.012-in. [7]To a maximum depth of 0.007-in. [8]To a maximum depth of 0.003-in.
[9]Deep undercutting pits.
Local attack in the form of pitting [10]To a maximum depth of 0.016-in. [11]To a maximum depth of 0.006-in.

countered in the vapor separators and frequently in the primary fractionation towers immediately following the cracking stills in thermal cracking units. The austenitic stainless steels, as would be expected, show maximum resistance to corrosion, but the beneficial effects of smaller chromium additions to steel, as in the 4-6 per cent chromium steels, are so pronounced that these materials are usually adequate for towers and associated equipment where elevated temperatures are maintained. In Tables 6 and 7 are presented the results of corrosion tests in vapor separating towers and in pressure distillate fractionating towers handling the products from thermal cracking of gas oils. An interesting feature of these tests is that they were made in four refineries belonging to the same company and operating under substantially the same process but with some difference in gravity and sulphur content of the crudes.

As the equipment at the different refineries was operating at somewhat different temperature levels, and as information on the sulphur content of the gas oils was provided, these two sets of data provide an opportunity to observe the effects of temperature and sulphur content upon corrosion. The comparison can be made most effectively by comparing the corrosion rates of mild steel in the various tests.

The tests reported in Table 6 were made in the top and bottom sections of vapor separators and those in Table 8 were made in the liquid and vapor phases in the bottom section of pressure distillate fractionating towers operating at elevated temperatures. It will be noted that, under those condiions that were most corrosive to mild steel, the 4-6 chromium steels showed resistance from 20 to 60 times that of the mild steel. The austenitic stainless steels were substantially free from attack. It is of interest also to note advantage of Admiralty brass over the alloys of higher copper content under these high temperature conditions.

Table 8 gives the results of corrosion tests in the fractionation and stabilization of untreated cracked gasoline derived from thermal cracking. These tests were all made at one refinery and represent performance in adjacent equipment. Corrosion of the various materials appears, in general, to approximate their performance in the uncracked gasoline from crude distillation as given in Table 4, and probably the same choice of construction materials would be indicated.

Table 9 gives the results of tests in the butts at the bottom of a re-run tower handling stabilized cracked gasoline that previously had been acid and caustic treated. There is a possibility of severe caustic embrittlement of mild steel at the temperature existing at the bottom of such a tower, which can be avoided by lining the lower portion of the tower with Monel or by the use of Monel or nickel-clad steel. ★ ★ ★

TABLE 9. Plant test in bottom of stabilized gasoline re-run tower.

Test made in bottom of tower in butts from stabilized cracked gasoline that had been acid treated and caustic washed. Gravity 25.4° API. (Basic) Sulphur content 0.422 per cent. Average temp. 300 F. Duration of test 350 days.

Material	Corrosion rate, inch penetration per year
Monel	0.0012
Nickel	0.0011
Inconel	0.0007
18-8 stainless steel (type 302)	0.0024
13 per cent Cr steel (type 410)	0.0020
4-6 per cent Cr steel (type 502)	0.0015
Chemical lead	0.0010
Ni-Resist (type I)	0.0057
Mild steel	0.0020*
Cast iron	0.0020

*Local attack in the form of pitting to maximum depth of 0.008-in.

Facilities being built at Avon refinery

JAMES SETH, Tide Water Associated Oil Company

TIDE Water Associated Oil Company is expanding facilities at its Avon Refinery by the addition of a 25,000 bbl per day capacity crude oil distillation unit.

EXCLUSIVE

This new unit and its auxiliaries represent an investment of some $2,500,000. It will supplement the catalytic cracking, alkylation, and isomerization facilities installed before and also during the war. The new unit will make possible the manufacture of more and improved petroleum products of all types.

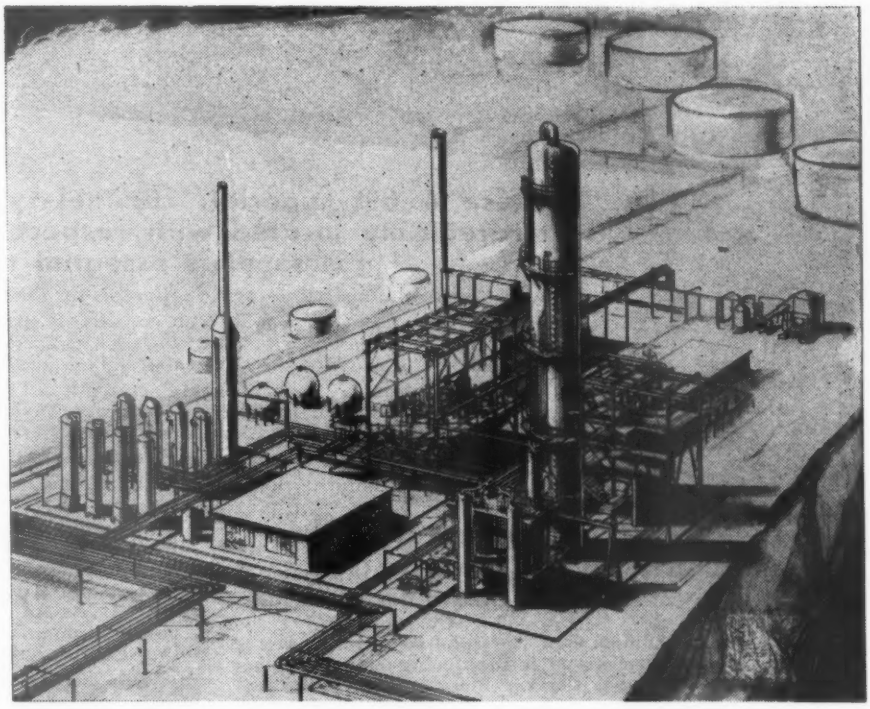
Construction is well under way on the new unit and the necessary auxiliary equipment and it is expected to be ready for operation by September, 1947.

The crude oil distillation unit is being engineered and constructed by Bechtel Corporation. Auxiliary equipment is being installed by various contractors and by Tide Water Associated Oil Company forces.

The distillation unit is of the single tower atmospheric type. Additional vacuum distillate will be recovered from the residuum in existing catalytic cracking feed preparation facilities. Process design and mechanical features are in accordance with specifications prepared by the Avon Refinery technical staff.

The unit was designed to process 25,000 bbl per day of crude oil from the Ventura Avenue field. This oil has a gravity of 30-31 deg API and a sulphur content of about 1.0 per cent.

Estimated yields of products from Ventura Avenue crude oil are shown in Table 1. Ample flexibility is being provided to handle considerable variations in product streams to allow processing of a wide range of crude oils and variation in product yields.



Artist's sketch of new distillation unit at Avon, California.

The crude oil charge is first preheated by heat exchange to reduce the viscosity. It then passes to the Petreco electrical desalter. Here a small amount of water is to be added and then settled out of the crude oil under the influence of a high potential electrical field. This reduces the salt content by about 90 per cent and makes possible a cleaner fuel oil as well as reducing corrosion in cracking and other process equipment.

The hot desalted oil that heretofore has been kept under pressure is then flashed into a 12-ft diam flash tower where the remaining water and light ends flash off and pass to the 20th tray of the main fractionator.

The bottoms from the flash tower then pass through the heater where they are heated to a temperature of 650 F, and then go to the vaporizer section of the fractionating tower.

The fractionating tower is 15½ ft in diam with 50 trays above the vaporizer section. Tray spacing is 30 in. This column is field fabricated due to the size and weight. Side stream draw-offs are provided for naphtha, kerosine, diesel oil, and gas oil. These side streams go to strippers for removal of light ends. Strippers for the kerosine, gas oil, and diesel oil are 5 ft in diam with 6 trays, whereas the naphtha stripper has 12 trays to obtain somewhat better fractionation.

The products after cooling are then to be caustic and water washed prior to blending to specifications or further processing.

Auxiliary work that was done in conjunction with this project has included site clearing, installation of the Petreco electrical desalter, and installation of a cooling tower to provide the cooling requirements of the new unit.

TABLE 1.

Approximate yields of straight run products from Ventura crude oil.

Product	Approximate yield, per cent
Light gasoline	19
Naphtha	15
Kerosine	9
Diesel oil	8
Gas oil	7
Residuum	42

★★★

THE AUTHOR

James Seth, a native of New Mexico, received a bachelor's degree in chemistry from Stanford University and a master's degree in chemical engineering from M.I.T. in 1936. Since that time he has been employed in the Research and Development Department of the Tide Water Associated Oil Company at Avon, California. His work has been in the field of light oil treating, and catalytic cracking, but is presently largely administrative.

6 CARBON BLACK PLANTS NOW FOR SALE OR LEASE

These 6 big-capacity, channel-type carbon black plants are strategically located with respect to sources of the adequate gas supplies essential to their operation.

War Assets Administration invites proposals for the purchase or lease of these six plants.

Machinery and equipment in each consists of special production units for the manufacture of channel-type carbon black including burners, scrapers, conveyers, pulverizers, loading and bagging equipment, and machine shop and laboratory equipment.

These six plants are capable of producing 20% of the total U.S. industrial production of channel black per year, 650,000,000 pounds. Subject to the terms of offer, they might well be purchased for use here, or for removal to South American or overseas sites to serve the industry abroad.

Credit terms may be arranged for the purchase of these plants.

War Assets Administration reserves the right to reject any or all proposals or offers received:

1.

MONUMENT, NEW MEXICO

(Plancor 2254)

CHARLES ENEU JOHNSON & CO.

Buildings and Facilities: Gas Desulphurization (Treater) Plant, designed capacity—21 million cubic feet of gas per day, Gas Supply Line, Carbon Black Plant—2 Burner Units, each consisting of 40 Burner Houses, 12′ x 160′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment—2 incomplete Burner Units with most of material for 32 Burner Houses each, and dwellings (14) near Carbon Black Plant Site.

Land: Approximately 175 acres.

For Sale or Lease—(A) As a whole, for operation at present location; (B) less either one or both of the incomplete burner units for operation at the present location, or—

For Sale—(C) As a whole, except dwellings, for dismantling and removal from site; (D) either one or both of the incomplete burner units for dismantling and removal; (E) dwellings only, if remainder of plancor is sold on a removal basis.

Gas Supplies: Gas is now being supplied by Warren Petroleum Company under a contract with present lessee.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, Commonwealth Bldg., 728 15th St., Denver, Colo.

2.

EUNICE, NEW MEXICO

(Plancor 2253)

PANHANDLE CARBON COMPANY

Buildings and Facilities: Gas Desulphurization (Treater) Plant, designed capacity—30 million cubic feet of gas per day, Gas Supply Line, Carbon Black Plant—4 Burner Units, each consisting of 42 Burner Houses, 12′ x 160′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment. Dwellings, 4 at Treater Plant Site, 14 near Carbon Black Plant Site. Total all buildings, 357,948 sq. ft.

Land: Approximately 148-1/2 acres.

For Sale or Lease—(A) As a whole, for operation at present location; (B) as a whole less 2 burner units and appropriate accessory buildings and equipment for operation at the present location, or—

For Sale—(C) As a whole, except dwellings, for dismantling and removal from location; (D) 2 burner units only and their appropriate accessory buildings and equipment for dismantling and removal from site; (E) dwellings to be offered separately if remainder of plancor is sold for dismantling and removal.

Gas Supplies: Gas is now being supplied by Phillips Petroleum Company under a contract with the present lessee that extends through 1949.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, Commonwealth Building, 728 Fifteenth Street, Denver, Colorado.

3.

SEAGRAVES, TEXAS

(Plancor 2316)

COLUMBIAN CARBON COMPANY

Buildings and Facilities: Gas Desulphurization (Treater) Plant, designed capacity—21 million cubic feet of gas per day, Gas Supply Line, Carbon Black Plant—3 Burner Units, each consisting of 60 Burner Houses, 12′ x 116′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment. Dwellings—4 at Treater Plant Site and 15 near Carbon Black Plant Site.

Land: Approximately 235-3/4 acres.

For Sale or Lease—(A) As a whole, for operation at the present location; (B) as a whole less 1 or 2 burner units and appropriate accessory buildings and equipment, for operation at the present location.

For Sale—(C) As a whole, except dwellings, for dismantling and removal from site; (D) either 1 or 2 burner units and appropriate accessory buildings and equipment for dismantling and removal from site; (E) dwellings to be offered separately if remainder of plancor is sold for removal from site.

Gas Supplies: Gas is now being supplied by Phillips Petroleum Company and in part by an affiliate of the present lessee, Columbian Carbon Company. The contract with Phillips Petroleum Company extends through 1949 and is transferable with the plancor. Columbian Carbon Company has expressed willingness to negotiate with prospective operators of the plant for such small additional supplies of gas as the company may have over and own needs.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, North American Aviation Plant, Grand Prairie, Texas.

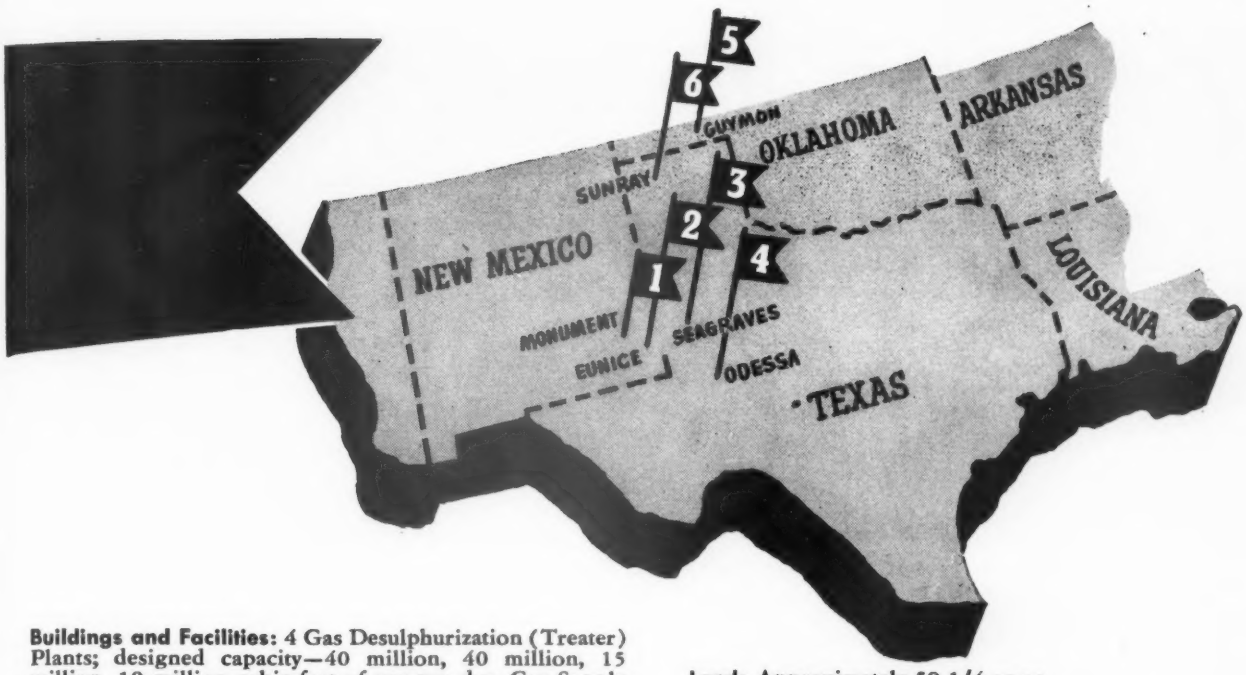
4.

ODESSA, TEXAS

(Plancor 2279)

UNITED CARBON COMPANY

(Subject to an interim lease held by United Carbon Co. expiring December 31, 1947.)



Buildings and Facilities: 4 Gas Desulphurization (Treater) Plants; designed capacity—40 million, 40 million, 15 million, 10 million cubic feet of gas per day. Gas Supply Lines—2 complete Carbon Black Plants. No. 1—one Burner Unit, consisting of 44 Burner Houses, 12′ x 144′ x 9′ and 3 Burner Units, each consisting of 44 Burner Houses, 12′ x 148′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment. No. 2—4 Burner Units, each consisting of 60 Burner Houses 12′ x 148′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment, and one incomplete, partially erected Carbon Black Plant. No. 3—most of material for 2 Burner Units, each consisting of 60 Burner Houses, 12′ x 148′ x 9′. Most of material for processing, storage and accessory buildings and equipment. Dwellings—4 at each Treater Plant Site and 72 at Odessa, Texas.

Land: Approximately 425-3/4 acres.

For Sale or Lease—(A) As a whole, for operation at the present location; (B) as a whole, less incomplete Plant No. 3 at present location; (C) any appropriate combination of treater plants, burner units, accessory buildings and equipment for operation at the present location.

For Sale—(D) As a whole, except dwellings, for dismantling and removal; (E) incomplete Plant No. 3 for dismantling and removal; (F) any appropriate combination of treater plants, burner units, accessory buildings and equipment for dismantling and removal from site; (G) dwellings to be offered separately if remainder of plancor is sold for removal.

Gas Supplies: Gas is now being supplied by Phillips Petroleum Company, Cities Service Oil Co., and Odessa Natural Gasoline Co., under contracts with the present lessee that run through 1949 with contingent extension.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, North American Aviation Plant, Grand Prairie, Texas.

5. GUYMON, OKLAHOMA (Plancor 2317) CABOT CARBON COMPANY

Buildings and Facilities: 4 Burner Units, each consisting of 48 Burner Buildings, 13′ x 124′ x 15′. Other buildings, Processing Shop, Warehouse and Service Buildings and equipment, 20 frame dwellings.

Land: Approximately 59-1/4 acres.

For Sale or Lease—(A) As a whole, for operation at present location; (B) less 2 burner units and accessory buildings and equipment for operation at present location, or—

For Sale—(C) As a whole, except dwellings, for dismantling and removal from site; (D) 2 burner units, appropriate buildings and equipment for dismantling and removal; (E) dwellings only, if remainder of plancor is sold on a removal basis.

Gas Supplies: Gas is now being supplied through facilities of the Gas Division of Cabot Carbon Company. Cabot Carbon Co., has expressed willingness to negotiate with prospective operators of the plant for necessary gas supplies.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, 2000 N. Memorial Drive, P.O. Box 1409, Tulsa, Okla.

6. SUNRAY, TEXAS (Plancor 2277) CONTINENTAL CARBON COMPANY

Buildings and Facilities: 6 Burner Units, 4 consisting of 42 Burner Houses each, 12′ x 160′ x 9′, 1 of 40 Burner Houses and 1 of 20 Burner Houses. Processing, storage and miscellaneous accessory buildings and equipment. 14 dwellings near Carbon Black Plant. Total all buildings, approximately 475,777 sq. ft.

Land: Approximately 155 acres.

For Sale or Lease—(A) As a whole, for operation at present location; (B) as a combination of burner units plus appropriate accessory buildings and equipment for operation at the present location, or—

For Sale—(C) As a whole, except dwellings, for dismantling and removal from site; (D) any combination of burner units plus appropriate accessory buildings and equipment for dismantling and removal from site; (E) dwellings to be offered separately if remainder of plancor is sold for removal from location.

Gas Supplies: Gas is now being supplied by Shamrock Oil and Gas Corporation under a month-to-month contract with the present lessee.

For a more detailed description of this property write: War Assets Administration, Office of Real Property Disposal, N. American Aviation Plant, Grand Prairie, Texas.

Prospective lessee or purchaser should arrange to obtain his own gas supplies. 1125-T

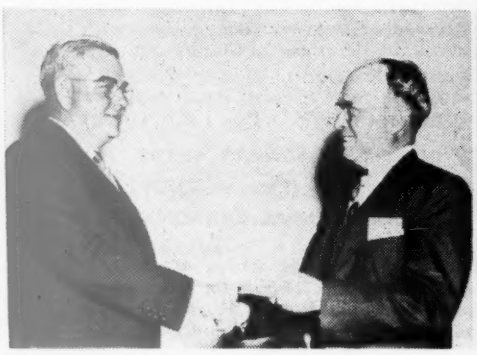
GOVERNMENT OWNED SURPLUS PLANTS

WAR ASSETS ADMINISTRATION

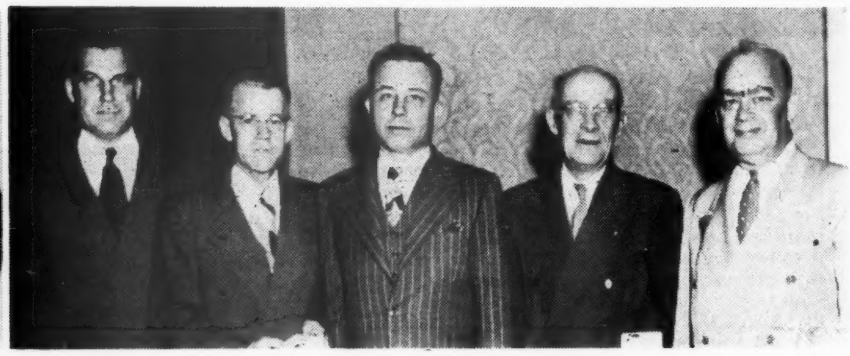
OFFICE OF REAL PROPERTY DISPOSAL

New officers and directors of Natural Gasoline Supply Men's Association. Back row, left to right: Warner Lewis, V. C. Canter, H. M. Rosevear, Dallas Deem, L. D. McKay, Cade C. Clover, Ray Roberts, and L. L. Dresser. Front row, left to right: J. H. Dunn, president, NGAA; J. N. McClure, treasurer, NGSMA; Roy Bush, first vice president; John Heinzerling, president, and J. A. Knebel, second vice president. Others are directors.

NGAA and NGSMA meet at Dallas



W. K. Warren of Warren Petroleum Company, Tulsa, Oklahoma, receiving Hanlon Award from J. H. Dunn, president of National Gasoline Association of America.



New officers of Natural Gasoline Association of America. Left to right: Albert H. Weil, vice president; Wm. F. Lowe, secretary-treasurer; C. R. Williams, president; Henry M. Brown, vice president, and James E. Pew, vice president. R. D. Gibbs, vice president, is not in the picture.

Feature of NGAA meeting, "Information Please," an open forum. Members of "board of experts" are on platform in background.

Death claims W. C. Trout

W. C. Trout, prominent Texas industrialist and president of the Lufkin Foundry and Machine Company, Lufkin, Texas, died April 24 in a Dallas hospital. He was 73 years old, having been born at Peterboro, Ontario, Canada, April 10. 1874.

At an early age his family moved to Milwaukee, Wisconsin, where W. C. Trout's father was associated with the E. P. Allic Company, later known as the Allis Chalmers Manufacturing Company. In 1893, W. C. Trout also accepted a position with Allis Chalmers as a draftsman in the saw mill department, soon thereafter becoming a foreman. In 1900 he became a contracting engineer

for the company, designing and selling lumber plants throughout the United States. Much of his work was in the South and he became impressed with its possibilities as a manufacturing area. He, therefore, in 1905, purchased a substantial interest in the Lufkin Foundry and Machine Company, which then employed 35 persons. Today the payroll numbers more than 600.

For the first 20 years of Trout's connection with Lufkin Foundry, the plant manufactured saw mill machinery, but in the middle 1920's most of its capacity was changed over to the production of oil-field pumping equipment and other specialties. In recent years the manufacture of large freight van trailers was added.

Trout's social, civic, religious, fraternal, and business affiliations were many. He served as president of the Lufkin school board for several years; was a past president of the Lufkin chamber of commerce; a member of the Lufkin Lions Club, Knight Templars, the Shriners; was a director of the Southland Paper Mills, Inc., the Texas Foundries, Inc., the latter industry he headed as president during its initial operation; the Lufkin National Bank; a stockholder in the Lufkin Publishing Company; was a past vice president of the National Manufacturers Association, a director of the organization for several years; and served as president of the Texas State Manufacturers Association for three years. He was a member and tireless worker in the Christian church, and served on the board of Deacons.

Surviving are his widow, Mrs. Nellie Percy Trout; three sons, Walter William Trout, Edward Percy Trout, and Howard James Trout, all of Lufkin; three sisters, Mrs. Nellie Davis of Monte Bello, California, Mrs. Jennie Steindorf of Pasadena, California, and Mrs. Peter Norgaard of Hart, Michigan; and six grandchildren.

Heads Columbia Steel

J. Lester Perry, assistant to Benjamin F. Fairless, president of the United States Steel Corporation of Delaware, has been elected president of Columbia Steel Company, U. S. Steel's West Coast subsidiary, succeeding the late William A. Ross, who died in San Francisco on April 19.

Perry, who has spent his entire career in the steel industry, began as a cost clerk and rose to the presidency of Carnegie-Illinois Steel Corporation, U. S. Steel's largest steel producing subsidiary. He retired from that post on July 31, 1946, to become assistant to President Fairless. Perry was scheduled to retire from the steel corporation on May 1, but has agreed to serve as president of Columbia until a permanent successor to Mr. Ross is elected.

From your smallest to your largest well, there is a Thompson Shale Separator and Sample Machine to meet your most critical mud cleaning requirements. Saves You Money . . . by removing destructive shale and abrasives from drilling mud, thus reducing wear and tear on costly drilling equipment. Sample Machine attachment provides accurate foot by foot samples of cuttings. We can deliver Now! Order through your supply dealer or direct from the factory.

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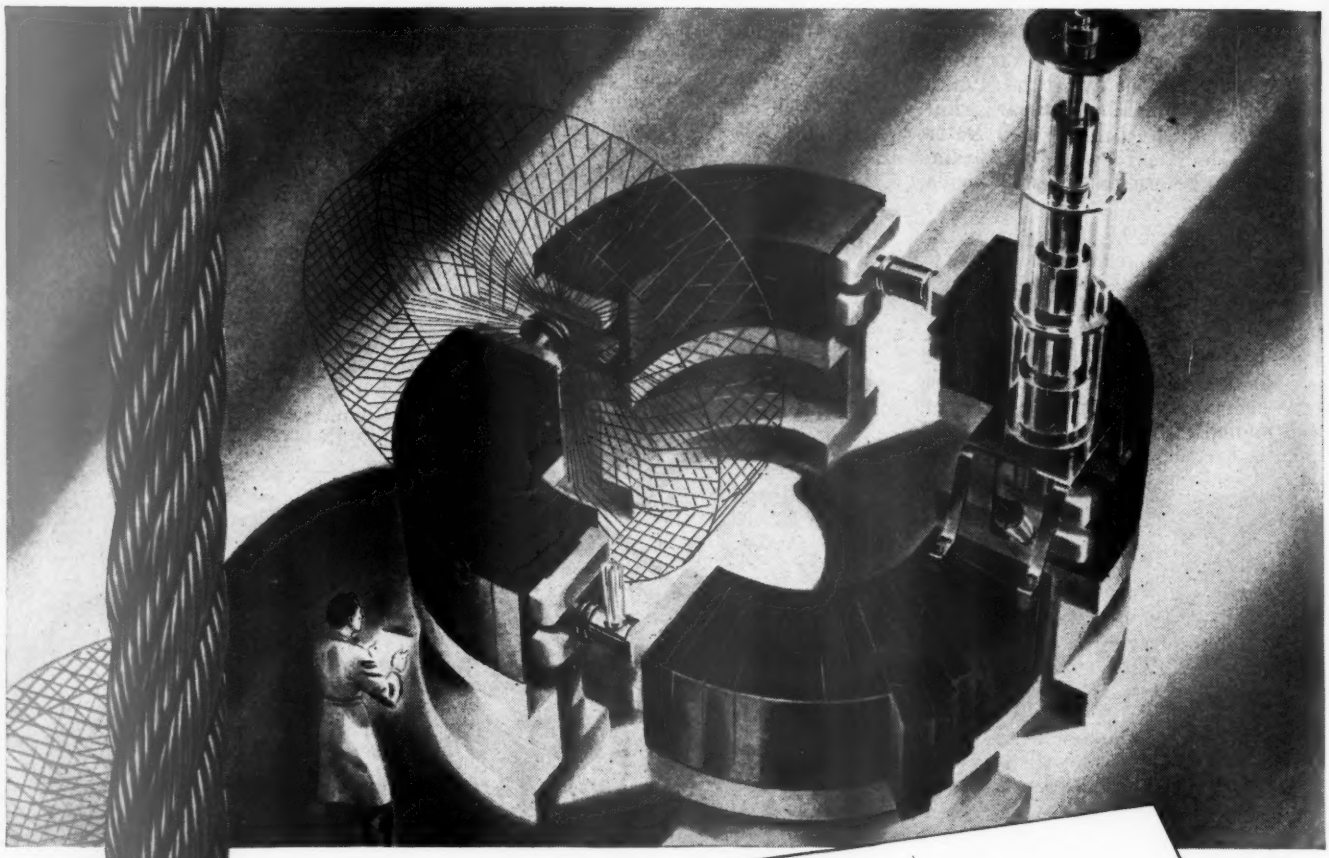
IOWA PARK, TEXAS

KEEPS DRILLING MUD CLEAN — PROVIDES TRUE SAMPLES OF CUTTINGS



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Like a synchrotron,* J&L Precisionbilt Wire Rope is made to do its work and do it well. And, just as men of science look to the future J&L men are planning and working to produce an even better wire rope for you—wire rope that will give you increased service and reduce your maintenance costs. Specify J&L Precisionbilt Wire Rope for your equipment.

**A 300 million-volt synchrotron that will produce energy similar to that of cosmic ray particles is being constructed by scientists. It will go a step beyond atom-smashing to study sub-nuclear particles.*

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J&L *Precisionbilt* PERMASET PRE-FORMED WIRE ROPE

new and improved machinery *and* equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

(1) Marley cooling tower

The Marley Company, Inc., Kansas City, Kansas, is offering the new Series 200 cooling tower, said to be a more flexible spray type natural draft tower. It may be purchased in various sizes, added to at any time as expansion is required, and used for open or closed cooling systems. The new Series 200 incorporates several new features developed during extensive field tests, as follows:

Standardized for volume production and economical construction.

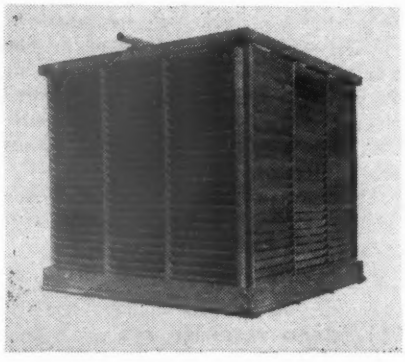
Designed in standard bays enabling an increase in tower size if requirements increase.

Standard atmospheric sections easily installed at any time for closed system cooling.

Rough lumber utilizing full dimension strength and low cost.

Designed to withstand 100 mph wind. Earthquake design or 112 mph design at small additional cost.

Heavy select heartwood lumber used throughout with galvanized bolts and special hardware at critical joints.



Water capacity of 65 to 1580 gpm or more.

Marley spray nozzles for perfect spray pattern.

Prefabricated and shipped "knocked down" with every member piece marked.

Complete erection, operation, and maintenance instructions supplied with tower.

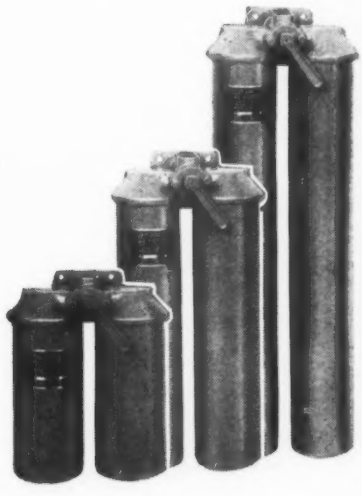
(2) Gage case

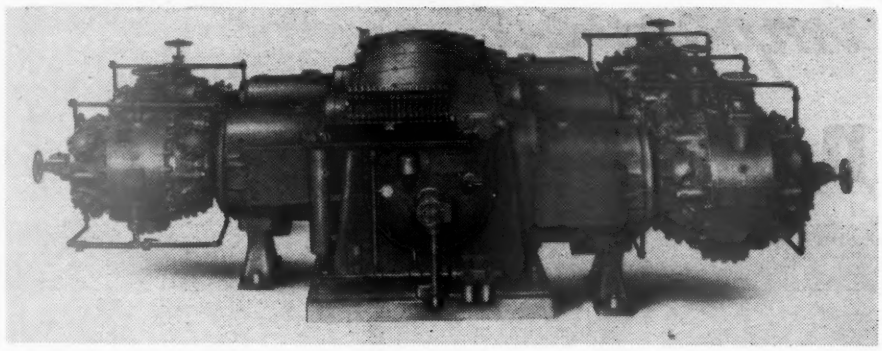
Helicoid Gage Division of American Chain and Cable Company, Bridgeport, Connecticut, announces a newly developed gage case. It is made of a high compression molded aluminum alloy and is called the Acaloy case. The surface of the case is treated by a patented process to prevent corrosion, and it is asserted that the case will withstand 1500 hr salt spray test. Over this treated surface there is a black baked-on finish. The case is said to be weather-proof, for it is provided with a synthetic rubber sealing gasket and a stainless steel snap ring. This new case is designed to accommodate safety blowout disks, which are supplied when required.

(3) Fuel oil filters

Three new sizes of Hilco Hyflow duplex fuel oil filters, for bracket mounting to diesel engines, have been added to the Hilco line of lubricating and fuel oil filtering equipment. The size units available makes it possible to apply these fuel oil filters to engines ranging from 200 hp. to 10,000 hp. Duplex operation permits an uninterrupted flow of fuel to the engine—by turning the valve control handle, the flow of oil is directed from one side of the filter to the other. A feature built into these units includes made-up type throw-away filter cartridges with gaskets attached, so there are no loose parts. The filtering material is a specially processed cellulose of very uniform density and so packed as to avoid the possibility of channeling. Filter cartridges are all metal covered to avoid the possibility of migration of any filtering material.

The Hilliard Corporation, 102 West Fourth Street, Elmira, New York, is the manufacturer.





Cooper-Bessemer "JM" Compressor.

(4) New compressor design

A motor-driven compressor of entirely new design, offering tremendous space saving possibilities compared with ordinary big scale industrial installations and especially adaptable for use in chemical, process, oil and gas, mining, construction, and general manufacturing industries, is announced by Stanley E. Johnson, vice president and director of sales of The Cooper-Bessemer Corporation of Mount Vernon, Ohio, and Grove City, Pennsylvania.

The new compressor has been designated the Type JM, available in six sizes and with a great variety of compressor cylinders, offering a wide range of volumes and pressures for handling air or gas. It is built with from one to six crank throws and ranges in horsepower from 500 to 2750. The compressor stroke is 14 in. and it operates at a speed of 300 rpm, which is the same as the company's Type GMV compressor. Power for driving it can be taken from a standard synchronous electric motor, an engine, or a turbine.

Of special importance is the fact that compressor cylinders for the new unit are the same as those used on the tried and proved Type GMV and are interchangeable. Provision can be made for low vacuums or for high pressures, as well as for all intermediate pressures.

Dimensions of the Type JM compressor range from 11 ft 7 in. to 24 ft 6 in. in length, and from 13 ft 9 in. to 24 ft 2½ in. in width. These lengths may vary slightly depending upon the size motor used, whereas the widths may vary according to the type of compressor cylinder used.

(5) Surface controller

The new Merla Type "AP" surface controller embodies a new design and construction for intermittent gas lift operations, according to the manufacturer, Merla Tool Corporation, Dallas, Texas. Combining regulation with time cycle control, this unit operates as a regulator when the valve is open, thereby using only the gas sufficient to complete an injection cycle with the lowest possible gas-oil ratio. By merely adjusting the pilot pressure, the unit can be made to operate as a straight time cycle controller if so desired.

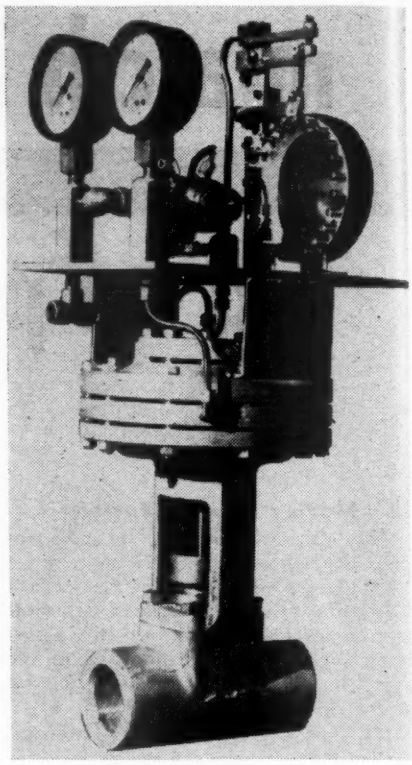
When the injection cycle starts and the desired casing pressure build-up is reached, the unit, acting as a regulator, closes the valve, independent of the time cycle unit, and holds the casing pressure constant until the time cycle unit closes.

By removing the time cycle unit and adapting the pilot pressure regulator to the valve body assembly, the unit can be used as a gas pressure regulator.

Valve can be operated from the bottom or top of the valve seat. Adapting the unit as a gas pressure regulator and placing the valve on top of the valve seat, the unit can be used as a back pressure valve.

The unit also can be used as a stop cocking unit with an exceptionally large capacity valve.

Merla Type "AP" Surface Controller.



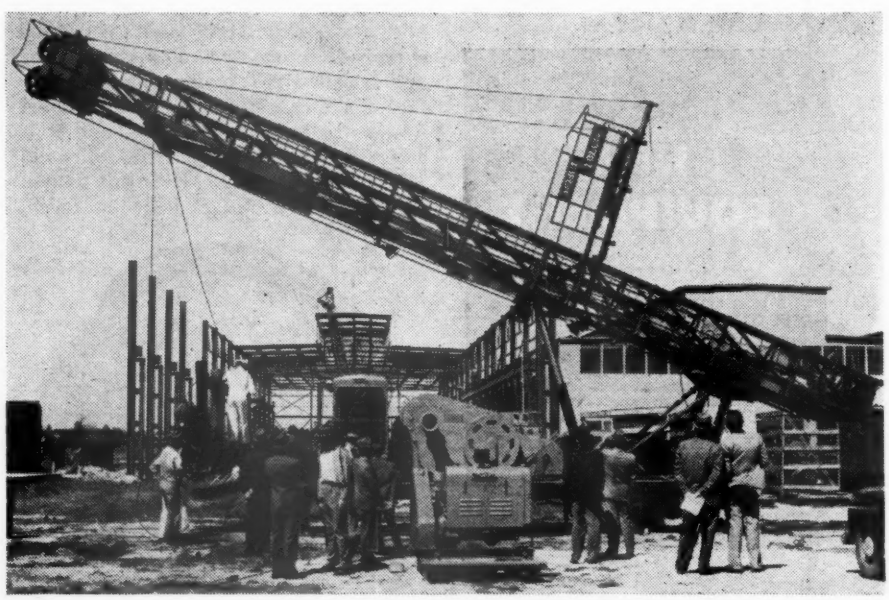
(6) Ideco rambler rig

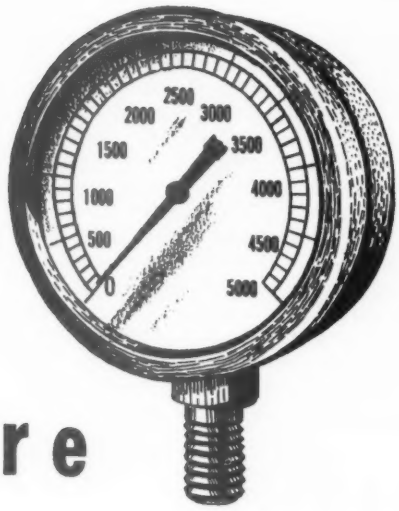
Gulf Coast operators have been given an opportunity to witness demonstration of the new Ideco Rambler Rig, shown by the Republic Supply Company at its central warehouse and store in Houston, Texas.

The Rambler Rig is a combination of Ideco Hydrair hoist and Kwik-Lift mast, designed for use on oil, gas, and water wells. Either truck or trailer mounted, the new unit, according to the manufacturers, provides unusual speed over the road, in rigging up, and in completing the job with the ultimate in smoothness of operation and economy.

Hydrair hoists are fluid-powered and driven by direct air clutches. Infinite, variable speed without gears is obtained through the combined use of a torque converter and a Hi-Lo instantaneous speed change arrangement. Fluid power automatically adjusts speed ratios to the most favorable operating conditions and provides maximum pull for coming out without shock or clutch slipping, it is stated.

Ideco Kwik-Lift telescoping masts are hydraulic operated for safety, speed, and convenience. A special patented design provides mobility, flexibility, and fast operation.

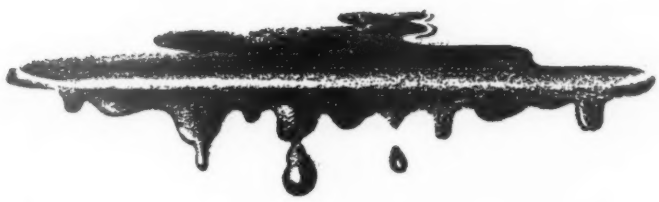




pressure

versus

molasses



Viscosity is a measurement of the ability of an oil to flow, or be pushed, through a given orifice, i.e., the pore space of a producing formation. An oil with a high viscosity is an oil which flows slowly through a given orifice, while an oil with a low viscosity is one which flows freely through a like orifice.

Viscosity fluctuates with variations in temperature and pressure of the reservoir. Just as molasses becomes very viscous on a cold winter morning, oil also becomes more viscous at lower temperatures. Even more important, however, is the role pressure plays in relation to viscosity. As the pressure on a reservoir is decreased and the dissolved gas comes out of solution, the density of the oil phase increases and the viscosity increases. The lowest viscosity for any given crude is coincident with saturation pressure.

If the viscosity of a crude is allowed to increase by letting reservoir pressure decline, the energy required to move the oil into the well bore and up to the stock tank is increased proportionally. *Therefore, many repressuring projects have been initiated primarily in order to maintain reservoir pressure near saturation pressure, thus keeping the viscosity of the crude at a minimum.*

These variations in viscosity with changes in pressure are unique with each particular crude, and only by accurate laboratory analysis can this relation, so valuable to the production of reserves under optimum conditions, be established.

The measurement of viscosity is one of eleven basic steps taken by Core Lab in the development of a comprehensive Reservoir Fluid Analysis report.

For more than eleven years Core Lab has played the leading role in making available to the industry the facilities and knowledge necessary to acquiring basic data prerequisite to better analysis, evaluation, and production of oil and/or gas bearing formations.

CORE LABORATORIES, INC. ● DALLAS 11, TEXAS

"If it's worth coring, it's worth analyzing."

CORE

PETROLEUM RESERVOIR

(7) Interior inspection

Development of a 100-watt black light one-third the size of a cigarette has made possible the use of sensitive inspection methods in hitherto inaccessible locations when used with a specially developed Borescope. This has been a joint development of the Magnaflux Corporation, Chicago, and the Lenox Instrument Company, Philadelphia.

When this new Borescope is employed for internal inspection, the inside surface is processed normally with Zyglo or Magnaglo materials as required. Inspection takes place by viewing the fluorescent indications of defects through the Borescope carrying the small black light at its viewing head. White light is also available at the head to aid visual checking of the location and appearance of the defects.

Fine cracks, seams, and lack of bond are then ground out within tolerance limits and the finished surface again processed and inspected to assure complete removal.

The use of this black light Borescope with Zyglo and Magnaglo is being extended to problems requiring internal inspection that up until now have been accomplished with much less efficient visual inspection using low intensity white light. Visual inspection can now be supplanted for interior inspection of critical products as it has been replaced for external surface inspection, it is asserted.

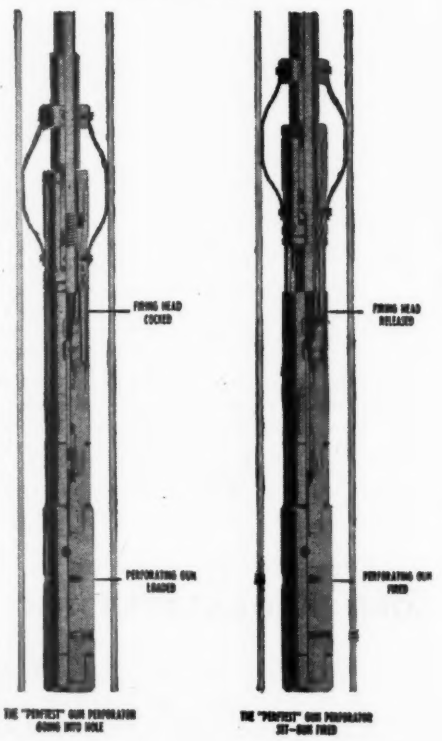
(8) Gun perforator

The Johnston "Perftest" all-purpose gun perforator provides operators with a safe, mechanically-operated gun perforator that can be run in the well on tubing or drill string and can be used either for perforating alone, or, when attached to the Johnston pressure recorder and formation tester, as the perforating unit in combined perforation and formation testing operation, according to the manufacturer, M. O. Johnston Oil Field Service Company, 3117 San Fernando Road, Los Angeles, California.

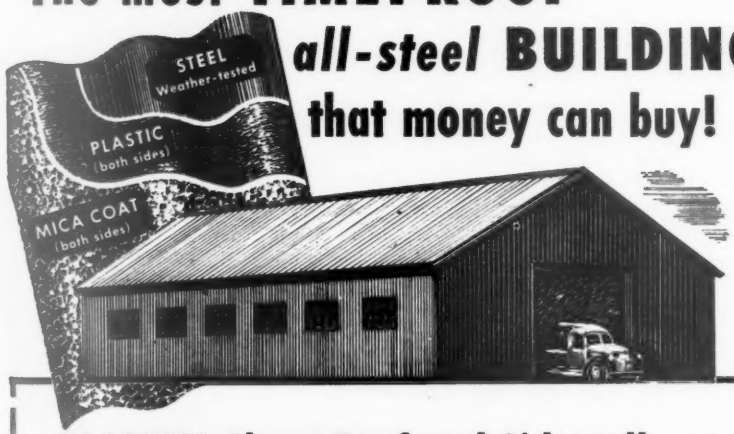
For perforating casing the gun perforator is lowered to the zone selected for perforation on the bottom joint of tubing or drill string. It consists of a mechanical firing-head to which may be attached any number of perforating gun sections. Each section fires four or five bullets to form a pattern of perforations 90 deg apart with a vertical measurement of 2½ in. from center-to-center.

The "Perftest" gun perforator is easily adapted to Johnston test equipment for combined perforation and test operations. By unitizing a Johnston "Perftest" gun perforator with a regular Johnston formation tester assembly any designated formation can be both perforated and tested in one round trip of tubing or drill pipe.

Simple top-hole manipulation of the string by the driller fires the gun perforator to perforate casing and actuates the tester assembly to test formation immediately following perforation.



The most TIMEPROOF all-steel BUILDING that money can buy!



PLASTEEL Sheet Roof and Sidewalls . . . Defy Even Sea Spray!

Build for permanence with the carefully engineered Soulé Utility Steel Building. Economical, too. Can be extended anytime in width or length without damage to first unit. Full 14-foot head clearance at eaves; vertical sidewalls. Completely free from interior columns. Equipped with time-proven Soulé steel windows and doors. Door openings 12-feet wide by 14-feet high. Architecturally good looking! Shipped complete with framing, sidewalls, roof, anchor bolts, frame bolts, straw nails and hardware for doors and windows. Carefully prepared erection drawings show where every part goes, and parts are individually marked. Can be quickly erected by inexperienced labor. Be sure the Soulé-way . . . you'll want to add to it someday!

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Prompt Delivery—*Shipment of complete buildings promptly made from our Los Angeles plant. Order direct or through your contractor.*

Size 40' by 100'—*4000 square feet of floor space! Can be furnished longer or shorter; multiples of 19'-9".*

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BUILT FOR OIL FIELD JOBS

In the oil fields, as elsewhere, Continental Red Seal engines are getting the call for more and more of the applications within their power range. And they're getting it wholly and solely on the basis of dependable performance, because there's a Red Seal model engineered and built expressly for each oil field job. It will pay you, too, to see your Red Seal engine dealer about any problem connected with oil field power needs.

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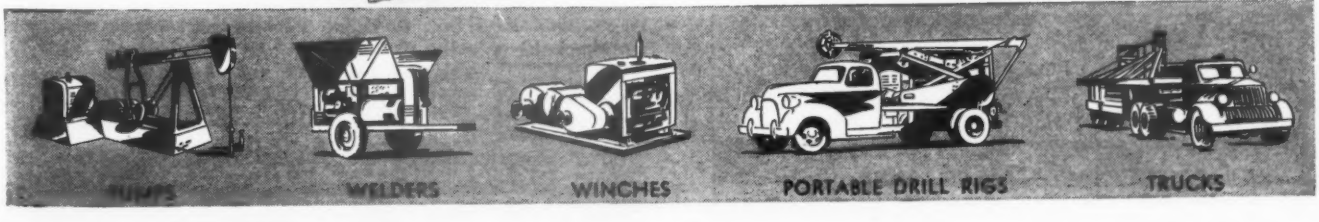
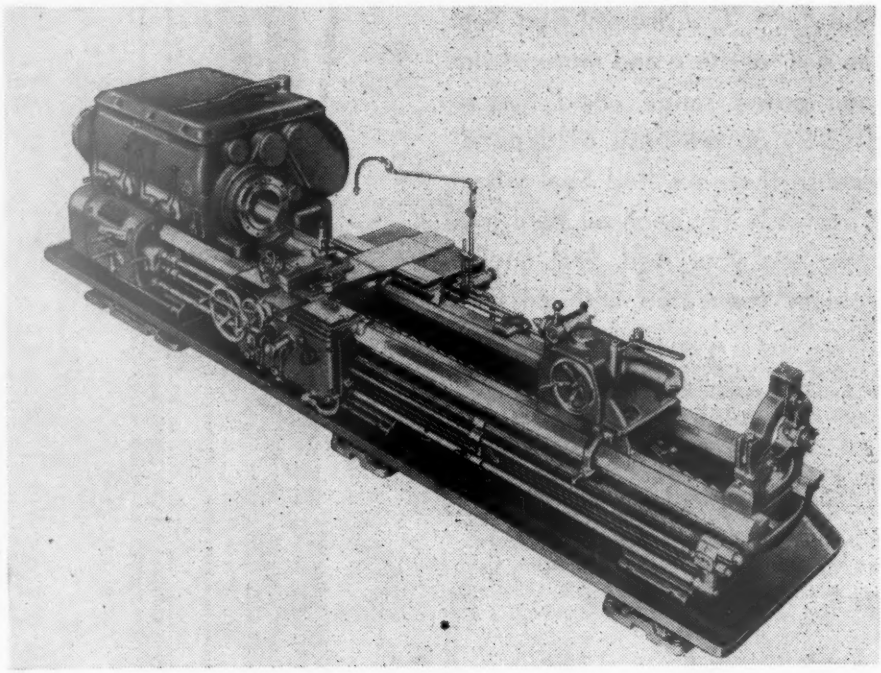


(9) Hollow spindle lathe

Designed to meet special requirements of the oil industry and to work on such long members as the oilfield "kelly," and other oilfield tool-joint jobs, a hollow spindle "oil country" lathe is announced by the Axelson Manufacturing Company, Los Angeles, California.

The new machine is manufactured in two sizes, a 20-in. lathe with 24 speeds and a 25-in. lathe with 16 speeds. Beds are of massive rigidity, giving the fullest support to the rest of the lathe assembly and maintaining perfect alignment under any strain or stress of heavy-duty cutting.

Lead screws are turned and ground before threading and preloaded and adjustable thrust bearings are provided at each end of the screw. The feed rod is used for all work except threading. Headstock case is a one-piece oil-tight unit in which the mounting of the hollow spindle is handled by two sets of Timken precision bearings. The forged alloy steel hollow spindle is ground to close tolerances and all gears in the spindle driving train are of alloy steel, carburized, hardened, and profile ground. Four levers control both the 24 and 16 spindle speeds.



Power is transmitted from the motor by means of multiplate forward and reverse clutches. The automatic spindle brake is synchronized with the main driving clutches, permitting rapid stop and reversal of spindle rotation.

(10) Wypo tip cleaners

The addition of Wypo tip cleaners, for use in cleaning oxyacetylene welding and cutting tips, to their line of apparatus has been announced by Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York.

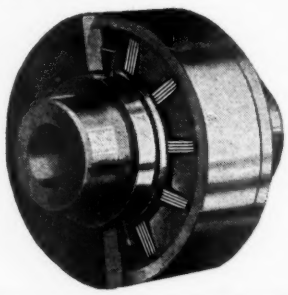
The economically priced sets of Wypo tip cleaners are available in two individual packages known as Set No. 1 and Set No. 2. Set No. 1 contains 12 cleaners for drill sizes ranging from No. 75 to No. 49. Set No. 2 contains nine cleaners for drill sizes ranging from No. 48 to No. 30. The Wypo tip cleaners are made of corrosion resistant stainless steel and each set is in a compact leather case.

FIVE VALUABLE SAVINGS

The KANTI-LEVER COUPLING has five valuable features of design, all of which save money for its owner. Not only does it protect you against the destructive effects of misalignment, but it develops a Cushion Torque that absorbs the hammer blows of sudden or reversing loads and dampens the torsional and radial vibration that cause wear, fatigue and sometimes failure of Motors, Speed Reducers, Ball Bearings and Productive machines. No other Coupling is like the KANTI-LEVER: it has a circular series of laminated Cantilevers of 200,000 lb. steel operating in slots, the tapered sides of which automatically stiffen the Cantilevers under increased loads and prevent backlash, while solid safety spokes prevent damage from excessive overloads. Special end play up to four inches is possible while the outer periphery is available as a brake drum for quick-stopping machinery. Send for Bulletin No. 22-A.

Kanti-Lever Couplings

4,000,000 h. p. in Use



BROWN ENGINEERING CO.

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ROCKFORD

OVER - CENTER CLUTCHES

EASY OPERATION
HIGH TORQUE
POSITIVE ENGAGEMENT
LARGE DRIVING AREA
SMOOTH RUNNING
INFREQUENT ADJUSTMENT
MINIMUM INERTIA

* The pressure plates in ROCKFORD Over-Center CLUTCHES have large area, accurately flat-ground surfaces for maximum contact with the facing material. Special alloy iron is used to withstand shock and heat strains. Provision is made for multiple driving, from the back plate. *Have hardened steel bearing inserts, where the roller cams operate.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER

1303 Eighteenth Avenue, Rockford, Illinois, U.S.A.

CONFIDENCE . . . how much is it worth?

IN 1846, twenty three years before the Golden Spike was driven at Ogden, Utah marking the completion of the first transcontinental railway, John August Roebling built America's first truly practical, wire rope suspension bridge. This bridge, which carried traffic across the Monongahela River for scores of years, stood as a silent testimonial to his confidence in a principle of bridge building which, in that day, was looked upon with considerable misgiving.

How much is this confidence worth to bridge engineers, and to humanity as a whole, today?

Had it not been for his confidence there would have been no Brooklyn, George Washington nor Golden Gate Bridges. Had it not been for your confidence in the company that bears this pioneer's name, there could have been no John A. Roebling's Sons Company.

Your confidence is valued above all of this company's assets. Every Roebling employee's job depends upon his ability to preserve that confidence by producing better products and by giving you better service than you can find elsewhere.

Any product is only as good as the organization that makes it.

For the Right Rope for Your Equipment Choose a "Blue Center" Steel Wire Rope!

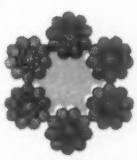
It's easy to find the right wire rope for your job when you can choose from a wide range—the one construction, size, and grade of steel that will give you most service at lowest cost.

That's why, whatever you need in wire rope, you're sure of finding it in Roebling's *complete* line of "Blue Center" Steel Wire Rope, in either preformed or non-preformed types. Illustrated are just a few of the more commonly used constructions. Each is the finest we know how to make . . . and each is made of Roebling's famous "Blue Center" Steel.

Your Roebling Field Engineer has the broad knowledge and experience needed to help you select the wire rope that will give you greatest returns in dependable, low-cost performance. He's at your service. Call him at our nearest branch office.

6 x 19 Standard Hoisting Rope

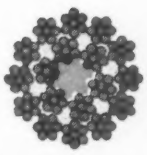
8 x 19 Extra Flexible Hoisting Rope



6 x 19 Haulage Rope

6 x 30 Flattened Strand Rope

6 x 7 Standard Coarse Laid Rope



18 x 7 Non-Rotating Hoisting Rope

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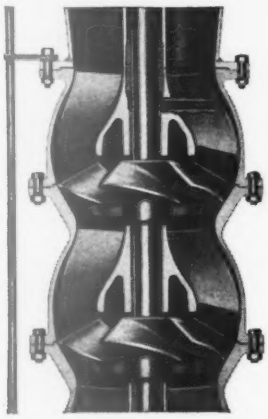
Manufacturers of Wire Rope and Strand • Fittings • Slings • Screen, Hardware and Industrial Wire Cloth • Aerial Wire Rope Systems • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel • Ski Lifts • Electrical Wire and Cable • Suspension Bridges and Cables • Aircord, Aircord Terminals and Air Controls • Lawn Mowers

Wire Rope Distributed by: **THE NATIONAL SUPPLY COMPANY • REPUBLIC SUPPLY COMPANY**

(11) Mixed flow pump

An important contribution to the successful regulation and control of huge volumes of water has been made by the Peerless Pump Division of the Food Machinery Corporation with the development of a mixed flow type pump.

This mixed flow type pump is described and illustrated in a new 24-page bulletin, supplying information to prospective pump buyers whose applications require moving or removing of water in capacities up to 220,000 gpm. The mixed flow pump complements the Peerless Hydro-Foil pump line, which includes a



Cutaway view of pump bowl unit.

propeller type pump also fully described in the new bulletin. The addition of the mixed flow design now offers the measurable advantage of flexibility where huge volumes of water are to be handled under varying conditions than might otherwise be undertaken by large capacity pumps.

Described advantages of the Peerless Mixed Flow type pump, embodying essential characteristics of both centrifugal and axial flow pumps, include its ability to move liquids against maximum heads with minimum submergence, adaptation to shallower sumps, utilization of higher speed motors against medium heads, and installation in minimum space.

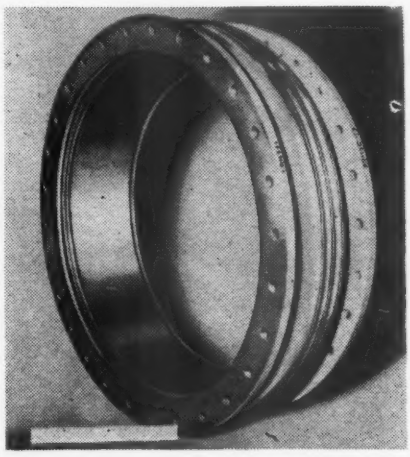
(12) MagniLastic products

The quantity production of a standard line of new low pressure-large diameter packless expansion joints ranging in sizes from 14 in. to 6 ft in diam is announced by MagniLastic, Chicago, Illinois.

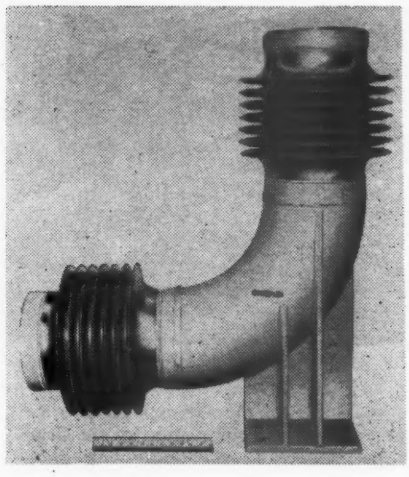
This latest addition to MagniLastic's complete line of expansion joints, applicable for all pipe sizes, temperatures, and pressures, is normally supplied in type 347 stainless steel to accommodate pressures up to 30 psi. Other metals may be specified when required.

Shown in the accompanying illustration is a 36-in. unit with three bellows flanges for a 3-in. total movement. For greater travel requirements, additional bellows flanges may be added. Forged steel 125 lb and flanges or spiral flanges are supplied.

MagniLastic also has recently added a new packless anchor base "Elbow" expansion joint to its standard catalog line. It can be supplied in all standard pipe sizes and in a choice of materials to meet



Expansion joint.



Elbow joint.

special corrosive, temperature, and pressure conditions.

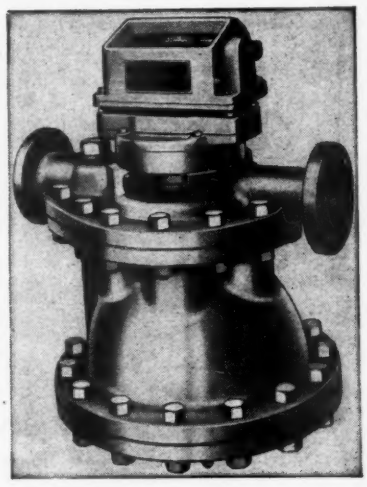
The accompanying illustration shows a 10-in. pipe size unit approximately 4 ft high that was built to accommodate 40 psi steam pressure. Each bellows allows 1½-in. total movement with 30-in. overall free length. The bellows of this unit is fabricated from stainless steel and the "L" used is standard weight 10-in. carbon steel pipe.

(13) Stainless steel meter

A new 1½-in. 50 gpm stainless steel meter for applications requiring stainless steel equipment to prevent corrosion, discoloration, or contamination has been announced by Fred C. Farmer, manager of meter sales, Bowser, Inc., Fort Wayne, Indiana.

In design and principle of operation it is basically similar to the Bowser Industrial Xacto meter that is so widely used in the petroleum, chemical, paint, and other industries.

It is constructed of stainless steel with the same internal chemically resistant parts that are used in the Industrial Xacto to reduce friction to an absolute minimum. Vertical piston operation minimizes cylinder and piston wear. There are few working parts. The direction o



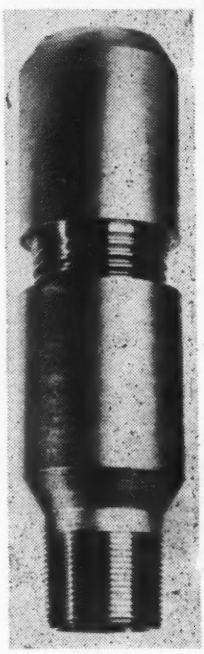
flow keeps any suspended material flowing evenly through the meter.

The combination of accurate, volumetric displacement measurement with stainless steel construction, Farmer said, makes available a meter for many production operations.

Production is already under way on the 1½-in. size. Maximum working pressure is 250 psi.

(14) Tube-joints

Longhorn Machine Works, 6823 Navigation Boulevard, Houston, Texas, announces a new tube-joint designed to protect tubing, speed up handling, and permit various uses of tubing in well completion and reworking operations where otherwise a string of drill pipe might be required.



Tube-joints are made from select high alloy steel stock, heat treated and carefully machined and gauged to assure 100 per cent interchangeability and long service, according to the manufacturer. Pipe end threads are API with tube joint threads modified API form. Joints are available in all tubing sizes and threads.

The new joints, according to the manufacturer, eliminate costly wear and tear on tubing, save time on round trips, prevent damaged or crushed tubing from tong action, and provide full opening for swabs and bottom-hole instruments.

Tube-joints come in a specially designed, skid-mounted, all-metal case for easy handling to and from location and to prevent damage to threads or joints.

MEASURE THE VALUE of CEMENTING EQUIPMENT BY *What it will do!*

THIS IS PERFECT CIRCLE CEMENTING

It washes the well bore clean wherever fluid action contacts it

It distributes slurry evenly at shoe point

It provides a safe float and rugged guide for the longest casing string

Larkin has pioneered many cementing equipment "firsts"... all designed to provide you with better, safer cementing jobs at greater and greater depths. That was our aim when we introduced Bakelite for shoe guides instead of concrete... when we designed and perfected "Perfect Circle Cementing." It's the most advanced method in side-action cementing shoes. It goes into action at the first stroke of the pumps. It incorporates every desirable feature that could be determined by querying qualified oil field personnel. And if you measure the value of your cementing equipment by what it will do... if you protect your well investment with the most modern floating equipment available... you'll chose Larkin "Perfect Circle Cementing." Other operators have all over the world. They bought through their supply store. Yours has a complete line of Larkin Cementing Equipment, too.

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WEST COAST REPRESENTATION: Howard Supply Co., Los Angeles
EXPORT: 19 Rector Street, New York City

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(15) Caliper and temperature logs

Halliburton Oil Well Cementing Company, Duncan, Oklahoma, has issued Bulletin No. 6 on the use of electrical caliper and temperature logs as a part of Howco electrical surveys.

(16) Control devices

"Industrial Control Devices," Catalog No. 8302, recently published by The Brown Instrument Company, a division of Minneapolis-Honeywell Regulator Company, contains important information on electric and pneumatic automatic control systems.

Accurate and dependable industrial control devices and safeguards are fully described in this catalog, with complete schematic diagrams, dimensional drawings and photographs of the instruments, as well as specifications, range charts, etc.

(17) International Diesel engines

Two new 8-page diesel engine pamphlets are being distributed by the Industrial Power Division of the International Harvester Company. They give complete specifications for the UD-14A and UD-18A diesel engines and power units recently placed in production by International. Bearing areas, moments of inertia, material specifications, and dimensions are but a few of the facts listed.

(18) Choosing and using tanks

An 80-page booklet, "The Choosing and Using of Tanks," has been released by Black, Sivalls and Bryson, Inc., Kansas City, Missouri. The points discussed in the illustrated booklet were largely gleaned from questions asked of the branch managers of Black, Sivalls and Bryson, Inc. all over the world, and represent the accumulated experience of a considerable number of men, over many years, with a large variety of production tank problems. Gwynne Raymond, chief engineer of the company, who prepared the book, originally presented "The Choosing and Using of Tanks" as an illustrated lecture before several chapters of A.P.I.

(19) Oil field drilling

The part played by diesel engines and diesel track-type tractors in oilfield drilling and maintenance operations themes a new 8-page color booklet, "Oilfield Drilling With Caterpillar Diesel Power." The publication sets forth applications of Caterpillar diesel engines for powering cable tool rigs, spudders, rotary tables, drawworks, drill rigs, and mud pumps, and shows how diesel track-type tractors are utilized in slush pit construction, equipment hauling, and land clearing and leveling.

(20) Linear Conversion Table

The Babcock & Wilcox Tube Company now has available a revised version of its linear table that converts inches and fractions of inches to decimal parts of a foot. The table (Technical Data Card No. 110A) should effect savings of time for those who deal with products, such as tubing, generally sold and quoted on a per 100 ft basis.

(21) Prefabricated pipe units

Designed so that it will be of great practical use to engineers and architects is a booklet of specifications for underground pipe distribution systems employing prefabricated insulated pipe conduit. Published by the Ric-wiL Company, Cleveland, Ohio, it is a comprehensive compilation of data arranged in convenient tabular form with supplementary diagrams and charts. Typical of the information contained are tables of dimensions for one or more conduits in one trench, tables of maximum conduit capacities of wrought iron and steel pipe sizes, and standard prefabricated expansion loop details. Loop dimensions expansion charts for both steel and wrought iron pipe are shown in convenient and usable form. Construction details of Ric-wiL insulated pipe units and available accessories are also given.

(22) Thermocouple accessories

Arklay S. Richards Company, Inc., 41 Winchester Street, Newton Highlands 61, Massachusetts, announces a new 16-page catalog describing its complete line of thermocouple lead wires, thermocouple wires, and other thermocouple accessories. Complete information is given with prices and recommendations, and prompt shipment can be made from stock on all common items shown in catalog.

(23) Houdry laboratories

Houdry Process Corporation, 25 Broad Street, New York 4, New York, has issued a booklet illustrating and describing the company's process and catalyst research and development, and its service laboratories.

(24) Price and parts list

Adams Engineering Company, 1618 North Fitzhugh Street, Dallas 4, Texas, has issued its latest price and parts list and information about "Standard" force feed lubricators and chemical pumps.

(25) Welding electrode specifications

"Tentative Specifications for Corrosion-Resisting Welding Electrodes," as recently prepared jointly by AWS and ASTM, is being distributed in booklet form by Arcos Corporation, 379 Gulf Building, Philadelphia 2, Pennsylvania.

(26) Color lithograph free

A free lithograph, 14 by 17 on heavy paper, of the painting "Oil Transport - Before Steel" may be had from Jones and Laughlin Steel Corporation, Pittsburgh 30, Pennsylvania. The painting illustrates the frantic rush in the 60's before the steel pipe line and steel tank car, to get crude petroleum to market by barging it down Oil Creek and the Allegheny River.

(27) Truck booklet

A comprehensive study of the road laws regulating trucks and trailers throughout the United States has been completed by the research department of The Four Wheel Drive Auto Company, Clintonville, Wisconsin, and has been compiled in booklet form. The booklet is the eighteenth edition of the size and weight restrictions to be published by the company since 1933.

(28) Emsco JV series

The Emsco Derrick and Equipment Company, Los Angeles, California, has issued Bulletin 231-A describing its new JV Series of oil-field swivels. This series includes the JV-7, JV-9, and JV-12. In addition to descriptive matter and pictures, the bulletin contains tables that give rating recommendations for the various type swivels.

(29) Corrosion test data

Comparative test data on Monel, 70/30 copper-nickel, mild steel, and other materials in refinery equipment handling caustic solutions is contained in a new 8-page bulletin, "Handling Caustics Without Corrosion Problems," of The International Nickel Company. Reports on plant corrosion tests in equipment used to remove mercaptans from petroleum products are included in the bulletin. In addition to test data, the bulletin contains data on use of Monel in caustic regeneration processes.

(30) Valve reference chart

A new, 20-page "Valve Cross Reference Chart" has been released by The Ohio Injector Company, Wadsworth, Ohio. The booklet contains a complete listing of OIC valve numbers in order, with their description. After previewing the new cross reference chart, a leading valve distributor stated, "it is the best organized and easiest to use reference chart we have ever seen and is invaluable in helping us select the right valve for the right job."

OIC manufactures a complete line of steel, iron, and bronze valves.

A hand to Raise on!

Ⓐces all!

The Ⓐ which appears on all Axelson oilfield production equipment, is your assurance that you are obtaining the best in service life, engineering skill and metallurgical research, with over 50 years of time-tested and proven customer satisfaction.

The Axelson line of oil production equipment has been developed with the primary thought of maintaining maximum oil production at sustained minimum cost.

The high quality and durability coupled with the corrosion and fatigue resistance that are marked characteristics of all Axelson products, pay big dividends in any pumping operation.

AXELSON MANUFACTURING CO. PLANTS—6160 So. Boyle Avenue (P. O. Box 98, Vernon Station), Los Angeles 11, Calif. • 3844 Walsh Street, St. Louis 16, Missouri OFFICES—50 Church St., New York City 7 • National Bank of Tulsa Building, Tulsa 1, Okla. Avda Pte. R. Saenz Pena 832, Buenos Aires, Argentina • DISTRIBUTORS—Jones & Laughlin Supply Company • Great Northern Tool & Supply Company • C. C. McDermond, Apartado 331, Maracaibo, Venezuela • Industrial Agencies, Ltd., San Fernando, Trinidad, B.W.I.

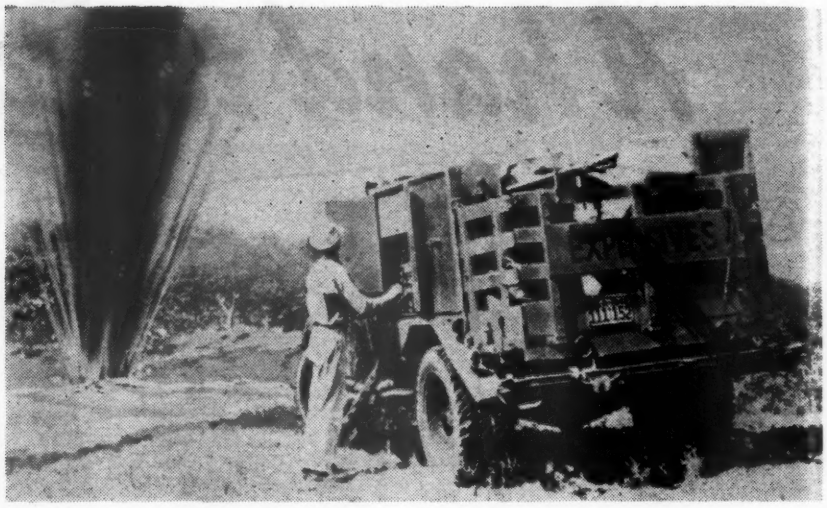
AXELSON

PETROLEUM INDUSTRY EQUIPMENT

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY Ⓐ

The story of oil

By **LYNE S. METCALFE**



Making a shot for a seismograph record.

PETROLEUM and its many derivatives touch the life, livelihood, and happiness of every man, woman, and child in the civilized world. Yet, comparatively little is known among the people generally, including those in our schools, of the origin, development, and final "harnessing" of this most vital of all basic industries.

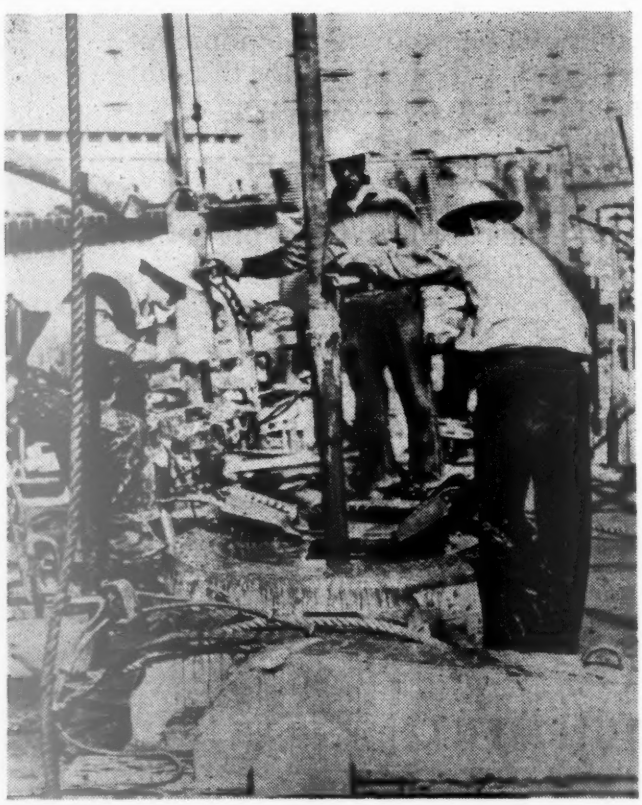
EXCLUSIVE

The story of oil, one of the most interesting and important stories of our time, has now been visualized in a new sound slidefilm by The National Sales Division of The Coca-Cola Company, and was produced by the Jam Handy Organization.

"The Story of Oil" is the first full color film produced in conjunction with another industry and shows in pictures with commentary the origin, development, and service of one of the basic industries in our modern world.

Produced in natural colors, "The Story of Oil," as told in this sound film, begins in the Stone Age of at least 50,000 years ago. At that time, when our precious supply of oil was being laid down, humans were living little better than beasts. They lacked fuel for light and warmth, yet beneath the ground they walked upon untold stores of liquid gold—oil that was to change the way of life for the whole world and to make possible the coming of the machine age.

All this is pictured dramatically in the opening sequences of the new film, which explains that, as the centuries passed oil seeped to the surface and man began to use it in small quantities for various purposes; but it was not until 1850 that an enterprising pioneer thought of drilling for oil. From this success a great industry was born. The film goes on to reveal that, although Nature provided this natural blessing, it has been the ingenuity of man that has changed petroleum from a black, odorous substance into its many and varied forms with thousands of uses. The film tells the story of this pioneering down to our own time.



A scene from the drilling sequences in the new sound slide-film, "The Story of Oil." The drilling crew is engaged in pulling drill pipe out of hole to change the drill bit.

Interested groups in schools, colleges, clubs, churches, and industry are given in this subject a vivid presentation of authentic facts and information—the result of two years' intensive research, including visits to oil fields, refineries, scientific laboratories, and interviews with distribution and market groups. The Coca-Cola Company, in making this picture, had the assistance of The American Petroleum Institute, Mid-Continent Oil and Gas Association, Western Oil and Gas Association, as well as a committee of experts in the petroleum industry.

In planning "The Story of Oil," the sponsor kept in mind the particular needs of the classroom teacher. The high school grades, where the study of basic industries has taken on new importance and interest in recent years, were especially considered. This film can easily be integrated with textbook study, talks, and demonstrations about the oil industry.

As the importance of oil during the war and at present has attracted widespread attention, the sponsors of this slidefilm have made the treatment broad enough to hold the interest of such groups as civic clubs, youth organizations—urban and rural—and oil industry associations, including the many branches of the automotive industry that depend upon petroleum for their very existence.

Showings may be arranged upon request without charge or obligation by consulting the local Coca-Cola bottler. Further details may be obtained from The Coca-Cola Company, National Sales Division, 515 Madison Avenue, New York 22, New York. ★ ★ ★

For any application in the 84 to 275 hp range, there is a proved Cummins Dependable Diesel that will maintain higher average output over a wide variety of changing load conditions.

CUMMINS DIESELS

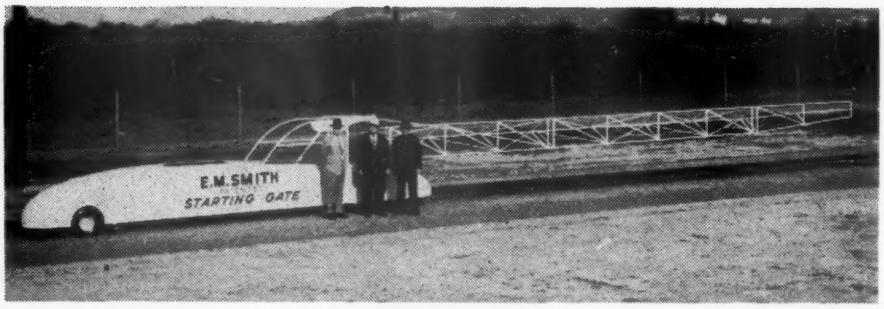
SINCE 1918...PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA

Globe starting gate

Globe Oil Tools Company, Los Nietos, California, is in the market with a new, revolutionary type of starting gate for running and harness races. The gate has already been adopted by the Western Harness Racing Association for its spring meeting at Hollywood Park, California, and by the Maywood Park Trotting Association, Maywood Park, Chicago, Illinois.

The Globe Starting Gate is a marked departure from the line of Globe products known to oil men throughout the world for a quarter of a century, and provides more evidence of the company's aggressive leadership in the field of efficiency engineering as well as its policy of keeping abreast of current needs in all fields of activity.



E. M. Smith, president (center); C. E. Whittaker, vice president and general manager, and John S. Goodwin, chief engineer, Globe Oil Tools Company.

E. M. Smith, president of Globe Oil Tools Company, is the originator of the Globe Starting Gate. "E. M." is one of the real pioneers in the oil tool manufacturing industry, and E. M. Smith Company, his original venture in this field, was parent organization to numerous subsequent "Emsco" companies throughout the United States and Great Britain.

Some years ago "E. M." sold practically all his Emsco properties and retired, but engineering and manufacturing exert strong influence after so many years, and again he is actively engaged in his chosen field as head of the Globe Oil Tools Company.

Get Accurate Readings of All Tank Levels with Telematic's Guardian **LIQUID LEVEL GAUGE**

TAKE ACCURATE READINGS of all tank levels on your farm in a few minutes, each tank level showing instantly on the Telematic Indicator Panel as fast as you can turn the dial and push the button. Level appears in feet, inches and one-eighth inches in lite-up numerals (finer if desired). Fast, utterly safe, truly accurate, much less costly than hand-gauging, Telematic operates with equally high efficiency in all weather and under any atmospheric condition. Gauges any number of tanks (cone—floating roof—Horton spheroid or sphere—Graver—balloon—breather roof) connected to one Telematic Indicator Panel. Distance between tanks or from tanks to indicator panel is not a factor. May be furnished with mechanical gauging unit at each tank or in combination with remote gauging. Also available with communications system for handset telephone plug-in at all points along the line. Write for cost-free Telematic booklet. No obligation.

TELEMATIC CORPORATION

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Macwhyte officers

At the annual meeting of stockholders of Macwhyte Company, wire rope manufacturers at Kenosha, Wisconsin, the following directors were re-elected to serve until the next annual meeting: Jessel S. Whyte, H. E. Sawyer, R. B. Whyte, R. P. Tyler, R. P. Cavanagh, J. T. Wilson, and W. Robert Johnston.

Immediately following this meeting, the directors elected Robert P. Tyler vice president in charge of sales. He was formerly general sales manager.

The following officers were re-elected: Jessel S. Whyte, president; H. E. Sawyer, vice president and treasurer; R. B. Whyte, vice president in charge of operations; H. A. Buntrock, secretary; and E. C. Berg, assistant secretary.

Filter firm purchased

W. R. Wheeler, Jr., manager of the M-C-M Machine Works at Oklahoma City, announces that his company has purchased the Sun Oil Filter Company of Oklahoma City and will immediately take over the manufacture and distribution of the Sun Oil Filter. The sales of the Sun Oil Filter will be handled exclusively through supply companies.

M. W. Reed promoted

Election of M. W. Reed as vice president in charge of engineering of Carnegie-Illinois Steel Corporation has been announced by C. R. Cox, president of this United States Steel subsidiary.

Reed has been chief engineer of the company since March 1, 1939. Previously he was vice president in charge of operations of the American Steel and Wire Company, another U. S. Steel subsidiary.

the Petroleum Engineer's CONTINUOUS TABLES

a daily reference for operating men

INSTALLMENT No. 119

A valuable and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their tenth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have been developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue; 116-118, inclusive, in the April, 1947, issue.

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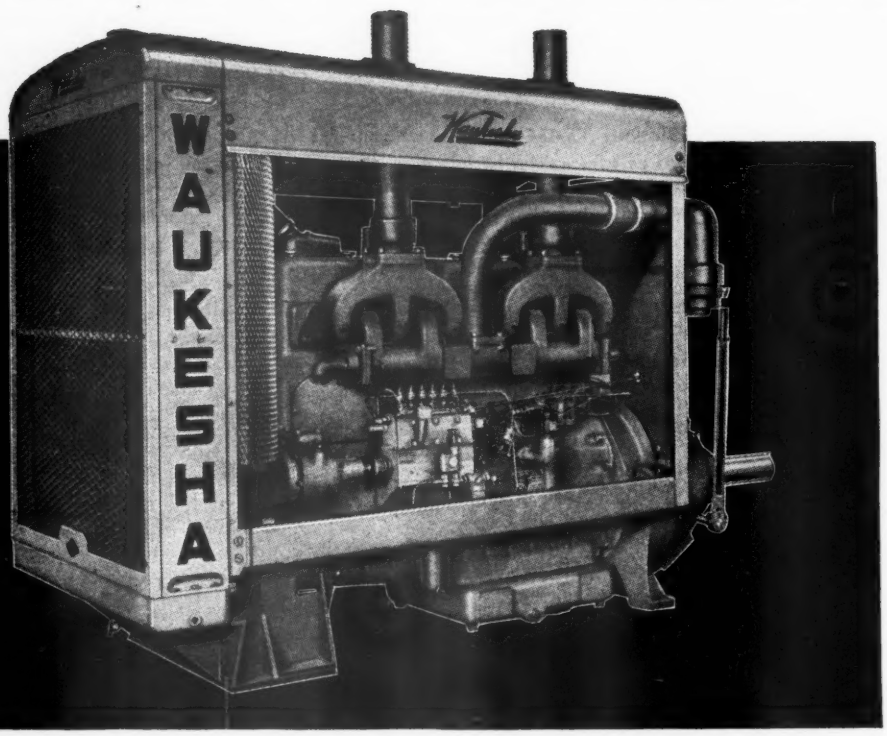
Waldrip Engineering Company	(sheet 8)	234	May	P 515.

There's *SuperPower* in this RUGGED, HEAVY-DUTY UNIT built around the

WAUKESHA *Industrial* DIESEL



Model

6-WAKDU

Six cylinders, 6¼" x 6½", 1197 cu. in. displacement, net horsepower at take-off shaft 190 maximum, at 1300 rpm.

for EVERY OIL FIELD NEED

- Oil Field Drilling
- Mud Pumps
- Pipe Line Pumps
- Compressors
- Well-Servicing
- Pumping
- Electric Power Generation

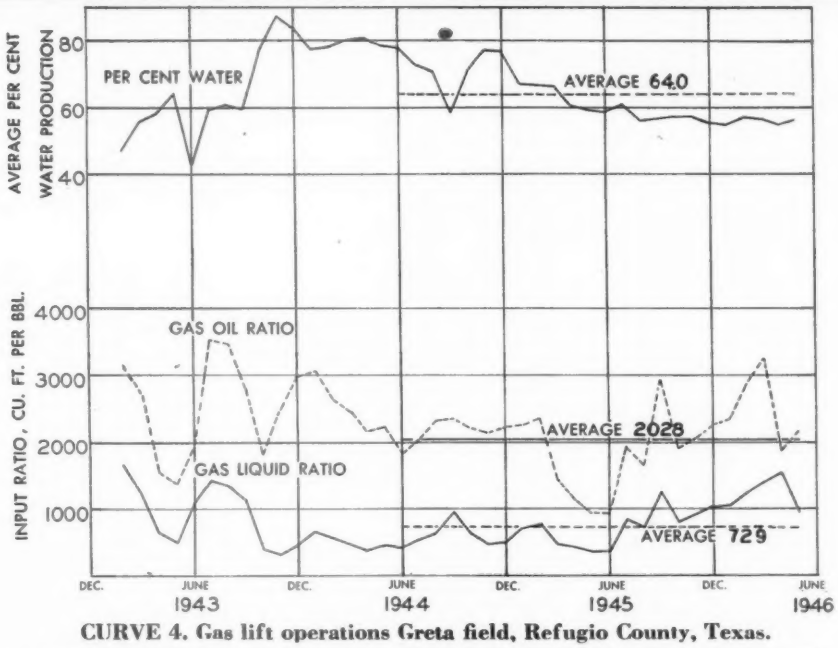
■ Here, indeed, is the answer to your heavy-duty power requirements—a big, four-cycle Waukesha Diesel that combines abundant power, flexibility, smoothness and acceleration with high fuel economy, long life and low upkeep. It incorporates the advantages of Waukesha's extensive wartime experience in building heavy-duty engines, plus 20 years of Diesel research and development.

Performance-proved features built into this modern Waukesha Diesel include: husky, 7-bearing crankshaft, equipped with 4¾" main bearings and 3¾" crankpins in steel-backed, copper-lead-babbitt; crankshaft journals and crankpins hardened to 600 Brinell for long life; hardened, wet-sleeve cylinders of Waukesha alloy iron, tested to 350-400 Brinell; oil cooled aluminum pistons fitted with four non-sticking, wedge-type compression rings and one oil control ring; full-floating piston pin, more than 2" in diameter, hardened and lapped to mirror finish; hardened exhaust valve seats; full pressure lubrication, with large capacity filters and oil cooler; American Bosch injection equipment. Gasoline-engine starting insures ample cranking capacity at all times, with prompt starts even in sub-zero weather. Electric cranking if preferred.

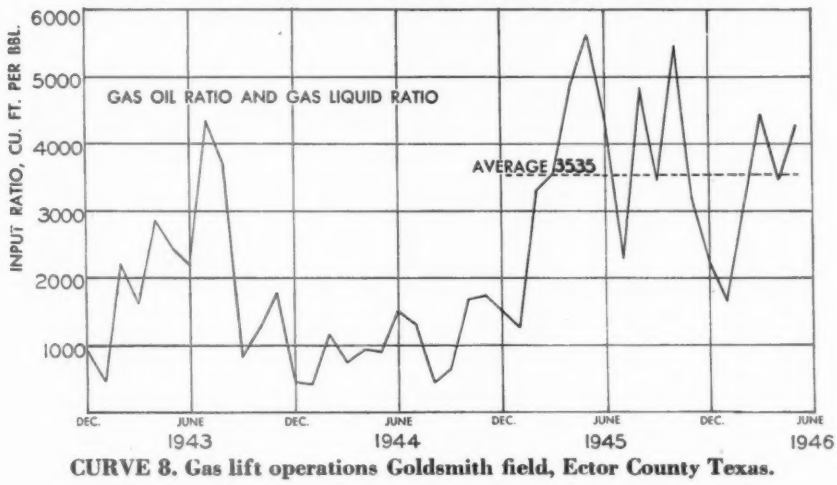
Consult Waukesha Engineers on your power needs.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS. • *New York, Tulsa, Los Angeles*

GAS LIFT DESIGN, INSTALLATION, AND OPERATION



CURVE 4. Gas lift operations Greta field, Refugio County, Texas.



CURVE 8. Gas lift operations Goldsmith field, Ector County Texas.

Curve 4 represents gas lift operations in the Greta field, Refugio County, Texas. Lift is 2000 ft, efficiency 11.27 per cent. Per cent water production is 64. The injected ratios are 2028 and 729 cu ft per bbl. Most of the production is obtained by means of automatic differential controlled valves, which have been installed for approximately ten years.

The amounts of gas injected are largely controlled by chokes on the surface, and operations are only efficient when large volumes are produced. The present installations are gradually being replaced with casing pressure controlled valves as individual tests indicate the need for this equipment. Gas is from gas wells.

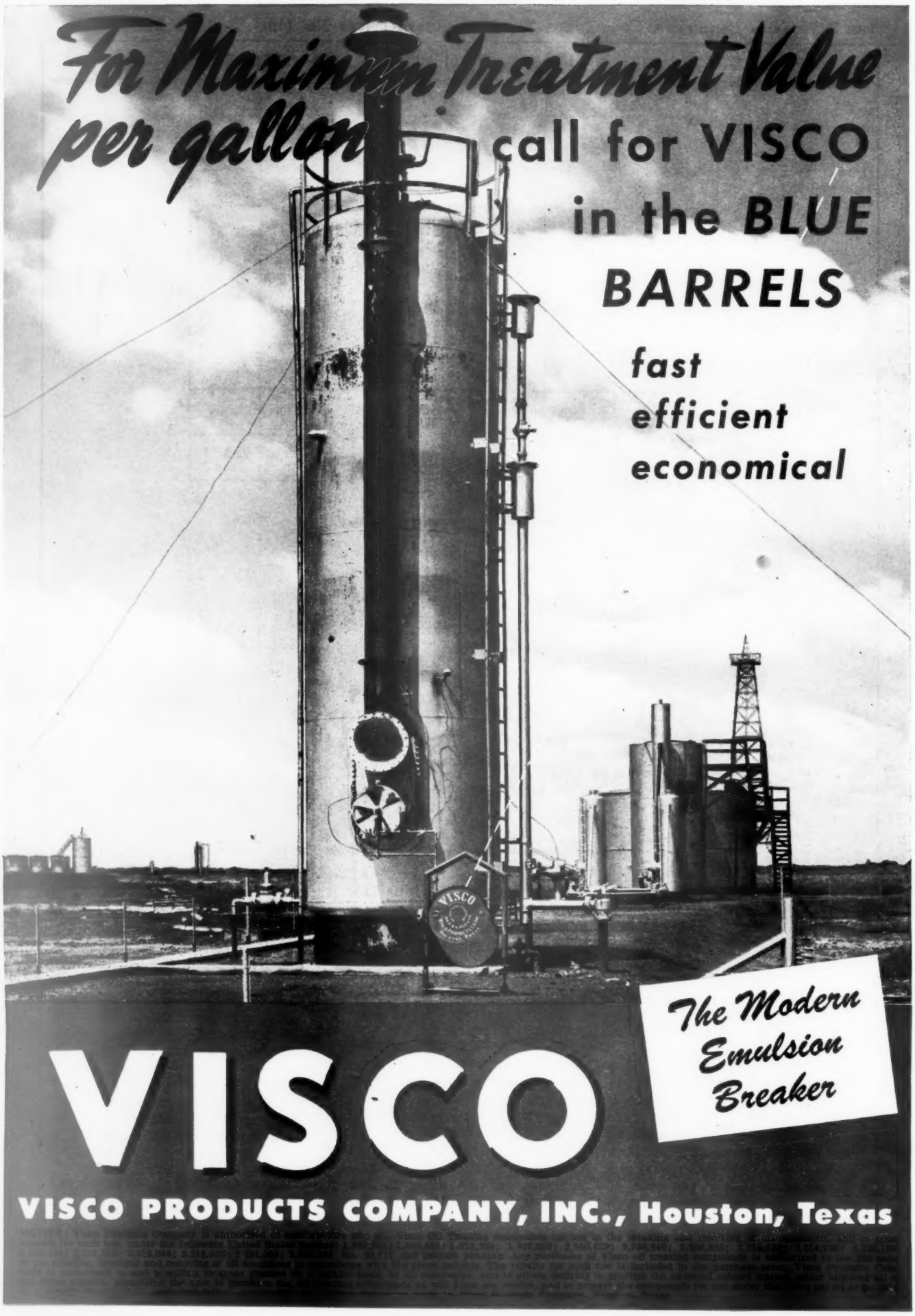
Curve 5† represents gas lift operations in the Seven Sisters field, Duval County, Texas. Here the lift is 2000 ft, water percentage 65.3, lift efficiency 9.4 per cent. Injected gas-oil was 3043:1, gas-liquid ratio 1141:1. Automatic differential controlled valves and wire line intermitters are used. Gas is supplied by a compressor station, which cycles the gas. The low efficiencies are due to the stripper nature of a portion of the production.

Curve 6† represents gas lift operations in the Aransas field, Aransas and San Patricio counties, Texas. Water production is 71.5 per cent, lift 3500 ft, efficiency 25.5 per cent. Injected gas-oil ratio is 1861:1, gas-liquid ratio 530:1. Gas is from a compressor station, which cycles the gas. The wells are produced by casing pressure controlled intermitters and automatic differential control valves. The latter are being replaced as rapidly as possible, due to their high susceptibility to sand cutting, which has given trouble in the past in this area.

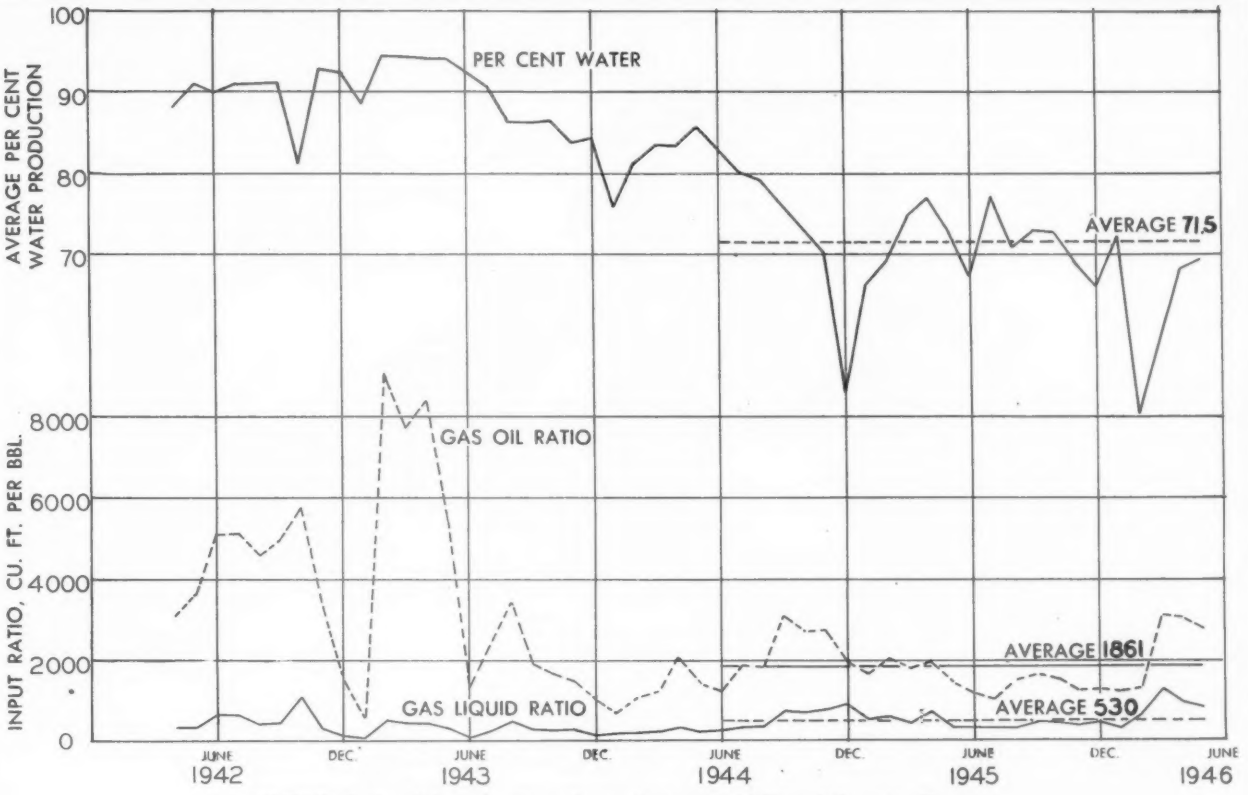
Curve 8 shows gas lift operations in the Goldsmith field, Ector County, Texas, from June, 1945, to May, 1946, inclusive. Here the lift is 3500 ft, water production is negligible, efficiency 3.8 per cent, injected ratio 3535:1. The wells are equipped with casing pressure controlled intermitters. The increase in input ratios during 1945 represents a change from agitation to true lift caused by a bottom-hole pressure decline. Considerable trouble due to corrosion of both surface and subsurface equipment accounts for the violent fluctuations in input ratios. Gas is from a gas well.

†Curves 5 and 6 are on Sheet 8 of this series of tables.

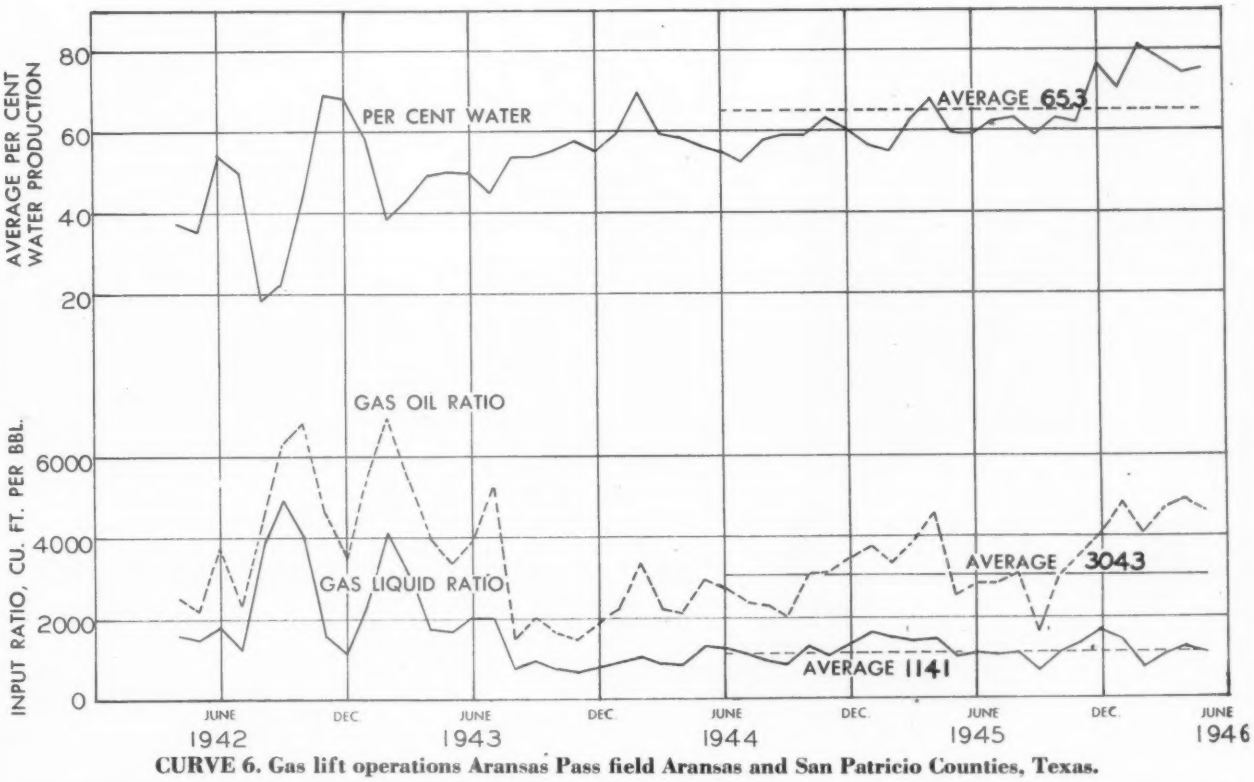
NOTE: These data are taken from the article, "Design, installation, and operation of gas lift equipment," by Louis F. Davis in the December, 1946, issue of *The Petroleum Engineer*, pages 60 to 77, inclusive.


For Maximum Treatment Value per gallon
call for VISCO
in the BLUE
BARRELS
fast
efficient
economical
VISCO
The Modern Emulsion Breaker
VISCO PRODUCTS COMPANY, INC., Houston, Texas

GAS LIFT DESIGN, INSTALLATION, AND OPERATION



CURVE 5. Gas lift operations Seven Sisters field Duval County, Texas.



CURVE 6. Gas lift operations Aransas Pass field Aransas and San Patricio Counties, Texas.

NOTE: These data are taken from the article, "Design, installation, and operation of gas lift equipment," by Louis F. Davis, in the December, 1946, issue of *The Petroleum Engineer*, pages 60 to 77, inclusive.

Here it is!

THE WALDRIP "321"—The only self-propelled servicing and drilling rig that drives into the location NOSE FIRST.

OUTSTANDING FEATURES

● Faster spotting at well location. ● Better balance with less weight. ● Less load over front wheels. ● Clear operating vision. ● Easily accessible motor in rear. ● Unit completely guarded by smooth, streamlined contour guards. ● Furnished with gas, gasoline, butane or Diesel engine. ● Furnished with torque converter or gear box. ●Equipped with 65', 60,000# or 90,000# hook load capacity Waldrip telescoping derrick.

WRITE FOR DETAILS

WALDRIP ENGINEERING COMPANY

11810 Center Street • Hollydale, California

ALIGNMENT CHART FOR BLENDING AND DILUTION CALCULATIONS

A type of problem common in pilot plant practice and recurrent also in large scale work is the problem of dilution. In blending, dilution of solutions and purging of tanks a differential equation must be set up either (1) for calculating the necessary rate of diluting stream that will accomplish the desired concentration change in a definite time, or (2) for calculating the duration of the operation at a given rate of diluting stream that will accomplish the desired concentration change, or (3) for determining necessary initial and final concentrations for a given rate of diluting stream and a given duration time of operation. In any case, it is necessary to assume instantaneous mixing, unless special data are at hand, and it is necessary to set up and solve a separate differential equation in each case.

The accompanying nomograph based on (1) constant volume for a given operation, (2) constant rate of flow of diluting stream, and (3) instantaneous mixing allows easy and quick determination of any of the five variables (duration time of operation, rate of flow of diluting stream, volume of system, initial concentration, and final concentration) when the other four are given.

The equation on which the nomograph is based was developed in the following way.

Let C = solute concentration (based on volume) at time, t.
V = total volume of tank
R = solvent rate (volume/time)

Then, by a solute balance:

$$VdC = RCdt$$

$$\int_{C_1}^{C_2} \frac{dC}{C} = -\frac{R}{V}\int_{o}^{t} dt$$

$$\ln \frac{C_1}{C_2} = \frac{Rt}{V}$$

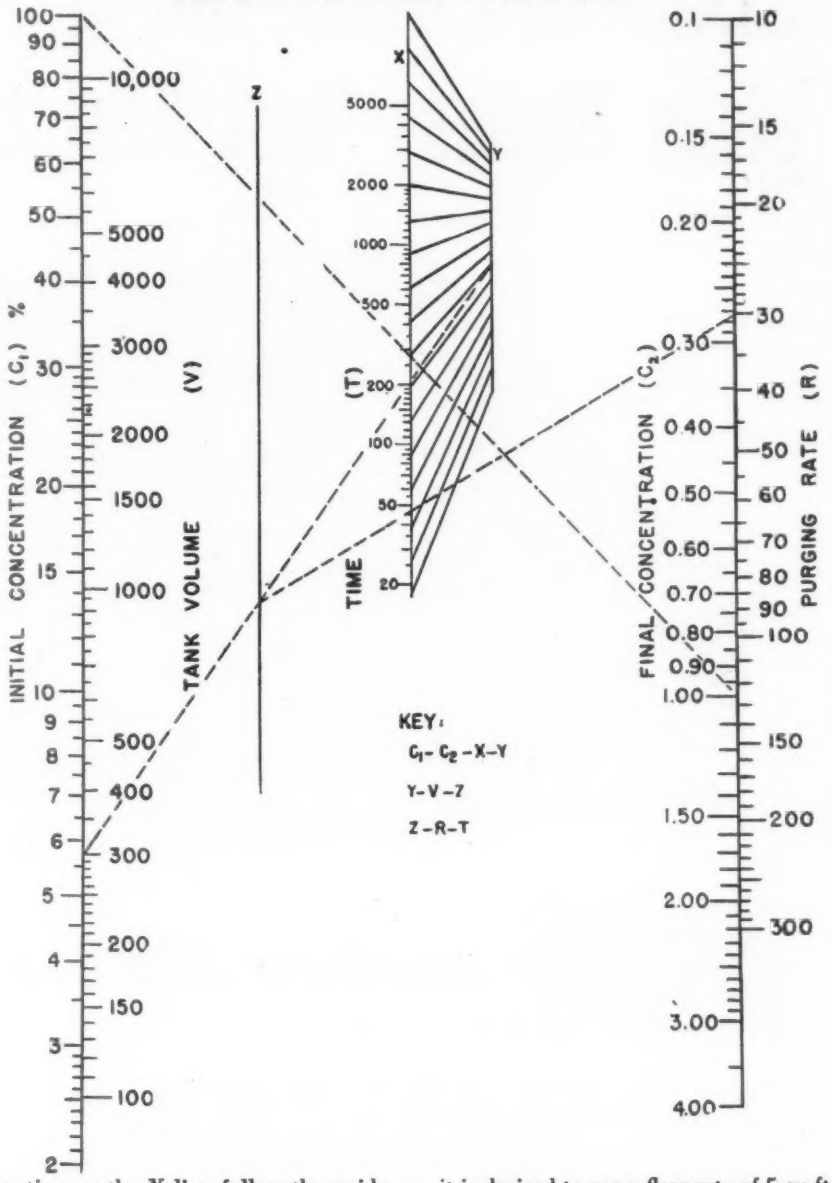
$$t = 2.303 \frac{V}{R} \log \frac{C_1}{C_2}$$

From this it is seen that C_1 and C_2 (initial and final concentrations) have the same units. R has the same volume unit as V and the same time unit as t.

The following examples will help to make the general method of using the nomograph clear.

Example 1: A 1000 cu ft tank containing 75 mol per cent hydrogen and 25 mol per cent carbon dioxide is to have the hydrogen content reduced to 1 mol per cent by bleeding in nitrogen at a constant rate. When the hydrogen content is down to 1 per cent the tank may be opened to the air and welding operations may proceed. How long will it take to do this? On the nomograph connect 75 on the C_1 scale with 1 on the C_2 scale. From the point of intersection on the X line follow the guide lines to the corresponding point on the Y line. Connect this point and 1000 on the V scale. Using the point of intersection on the Z line as a pivot one can readily estimate the flow rate necessary to complete this operation in a reasonable time. At a flow rate of 30 cu ft per min the operation will require 140 min.

DILUTION CALCULATION NOMOGRAPH



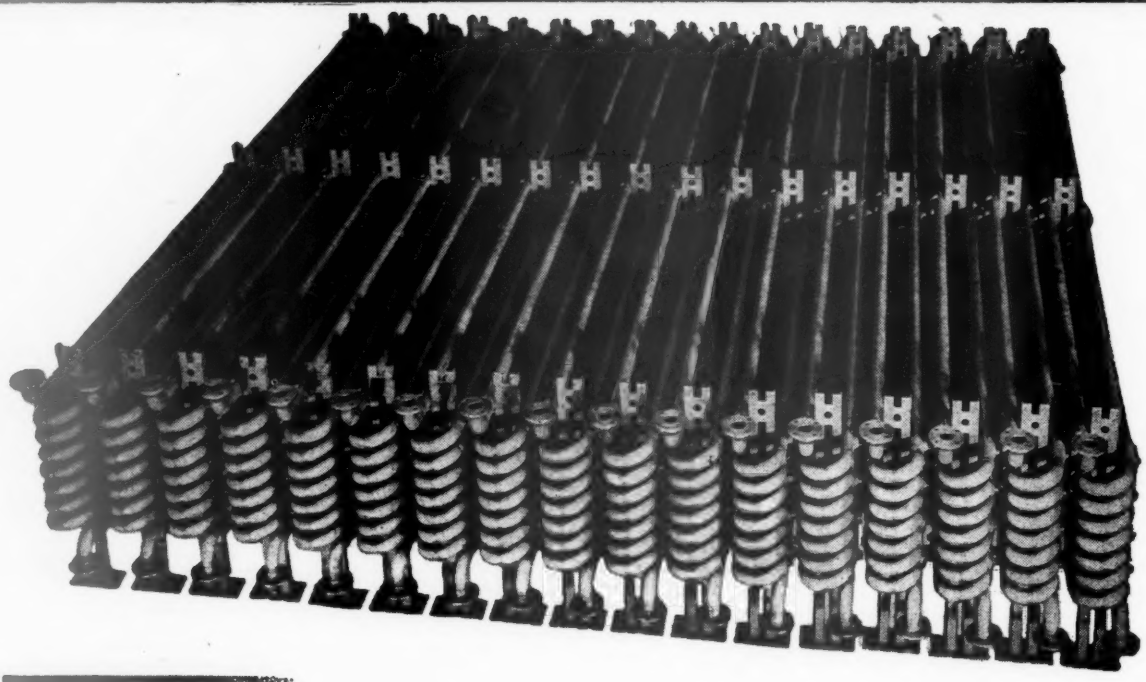
Example 2: A 300 cu ft tank containing propane at atmospheric pressure is to be purged with nitrogen at the rate of 30 cu ft per min, until the propane content is not more than 1 per cent by volume. How long will it take to do this? As shown by the lines already in place on the nomograph the time required is 46 min.

Very slow flow rates (less than R = 10) can be handled if it is seen that V and R occur in ratio. If, for example, it is desired to use a flow rate of 5 cu ft per min into a 300 cu ft tank this is the same as 50 cu ft per min into a 3000 cu ft tank.

Obviously, in any actual purging operation there will be a certain amount of displacement because mixing is not perfect. This will result in a shorter time being required than is calculated. The time estimated from the nomograph will, therefore, be the maximum time required. If it is desired to dilute a gas accurately to a certain concentration in the manner outlined above precautions should be taken to have the mixing as nearly complete as possible. This means that the rate of flow of the diluting stream should be small in comparison with the tank volume and that mixing devices should be used.

Taken from the article by W. C. Frishe in the February, 1947, issue of *The Petroleum Engineer*, pages 182 to 184, inclusive.

STAINLESS Steel Tubing gives Highest Heat Resistance



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High strength combined with long life under continuous or intermittent attacks by hot gases and fluids are advantages of stainless tubing that pay off for you in terms of trouble-free operation, few shutdowns, lower maintenance costs. The same properties that give stainless tubing its high heat resistance give it other valuable advantages for high temperature services—stubborn resistance to corrosion, scaling, creep, oxidation, and abrasion.

From the wide range of B&W Croloy Stainless Steel Tubes you can get the tube having the property best suited for any specific set of service conditions—the best economic balance between initial cost and operational efficiency. For Stainless Croloys embrace the widest choice of grades and analyses available from a single source—in both SEAMLESS and WELDED types.

Call on Croloy when tough tubing jobs call for stainless.

TA-1372

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Water-Tube Boilers, for Stationary Power Plants, for Marine Service • Water-Cooled Furnaces • Superheaters • Economizers • Air Heaters • Pulverized-Coal Equipment • Chain-Grate Stokers • Oil, Gas and Multi-Fuel Burners • Refractories • Process Equipment.

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PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.

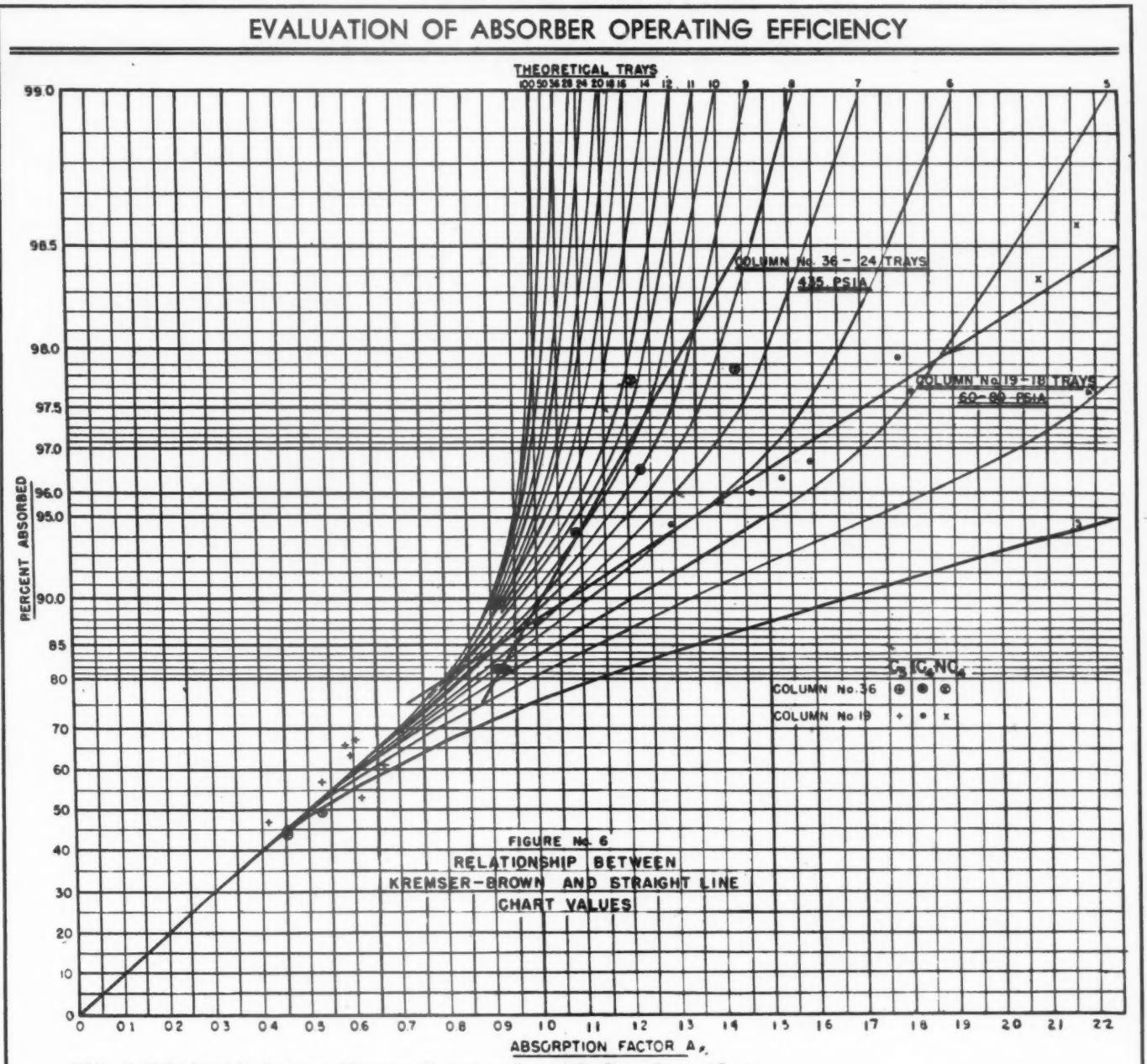

FIGURE No. 6
RELATIONSHIP BETWEEN
KREMSER-BROWN AND STRAIGHT LINE
CHART VALUES

FIG. 6. Relationship between Kermser-Brown and straight line chart values.

Additional features of the straight line chart are presented in Fig. 6. Here we have plotted the operating line for column 19 from Fig. 4, and column 36 from Fig. 5, on a straight line chart to which has been added a grid indicating the "Brown per cent yield versus A_e relationship" for 3 to 100 theoretical trays. Also, the per cent key component yield from 70 per cent on down to 0 per cent have been indicated. These particular chart additions were made for the purpose of demonstrating:

1. The wide changes in Kremser-Brown theoretical tray efficiency shown by a single column operating at a given basic tray efficiency as its per cent recovery of key component is changed.

2. The marked difference in relationship existing between per cent recovery and A_e for recoveries of over 75 per cent, and under 60 per cent.

The wide range shown by the theoretical Kremser-Brown tray efficiencies of Fig. 6 are typical. Also, it should be noted that whereas 24-tray column 36 ranges through an *increasing* theoretical tray efficiency of 16.5 per cent to 44.2 per cent to 34.6 per cent in going from a 75 per cent to a 98.5 per cent key component recovery, 18-tray column 19 goes through a reverse, or *decreasing*, efficiency range of 100 per cent plus down to 25 per cent for the same key component recovery change. The magnitude and reversed direction of these two sets of tray efficiencies aptly illustrate the inadaptability of the conventional theoretical tray efficiency factor to accurate specification definition, or precise column operation comparison.

Although the test points for component recoveries below 70 per cent on Fig. 6 are somewhat scattered, it is clearly evident that one single line will well represent the average of both column operations. This observation conforms with the well understood absorber relationship that in the actual commercial column, excess trays are always present for the "under 70 per cent recoveries," and therefore such recoveries are functions of absorption factor only—and independent of actual tray number or tray efficiency.

Taken from the article by E. G. Rogatz and J. A. Richardson in the January, 1947, issue of *The Petroleum Engineer*, pages 110 to 118, inclusive.

Piping Jobs move faster when all materials are CRANE

You save time on piping specifications! . . . you save time in ordering materials! . . . you save on installation time! Standardizing on Crane equipment does all that . . . and more . . . on every refinery piping job.

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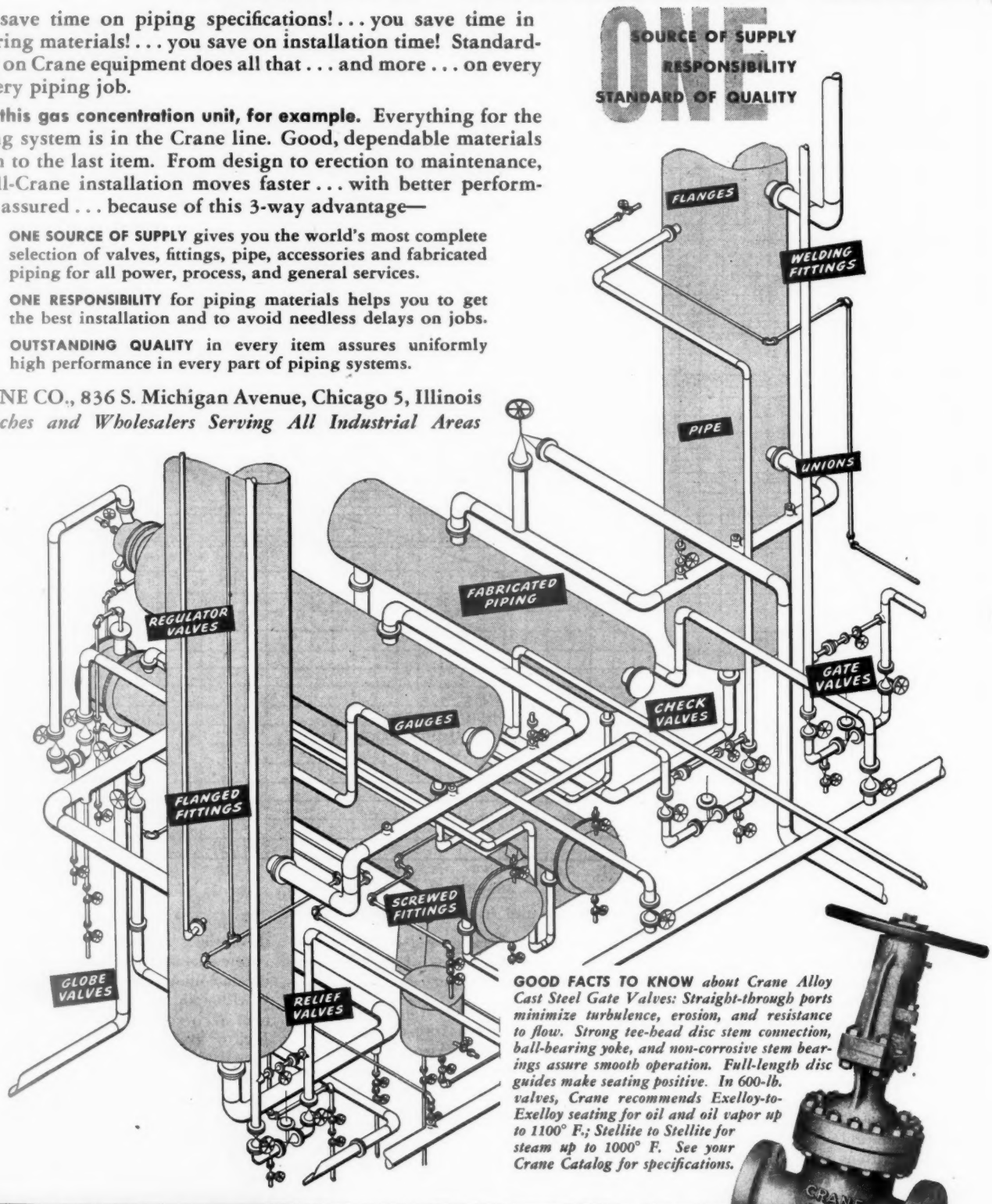

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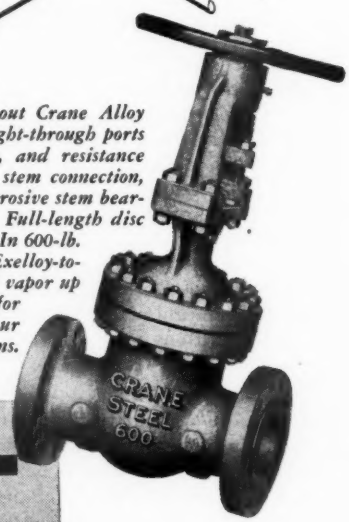

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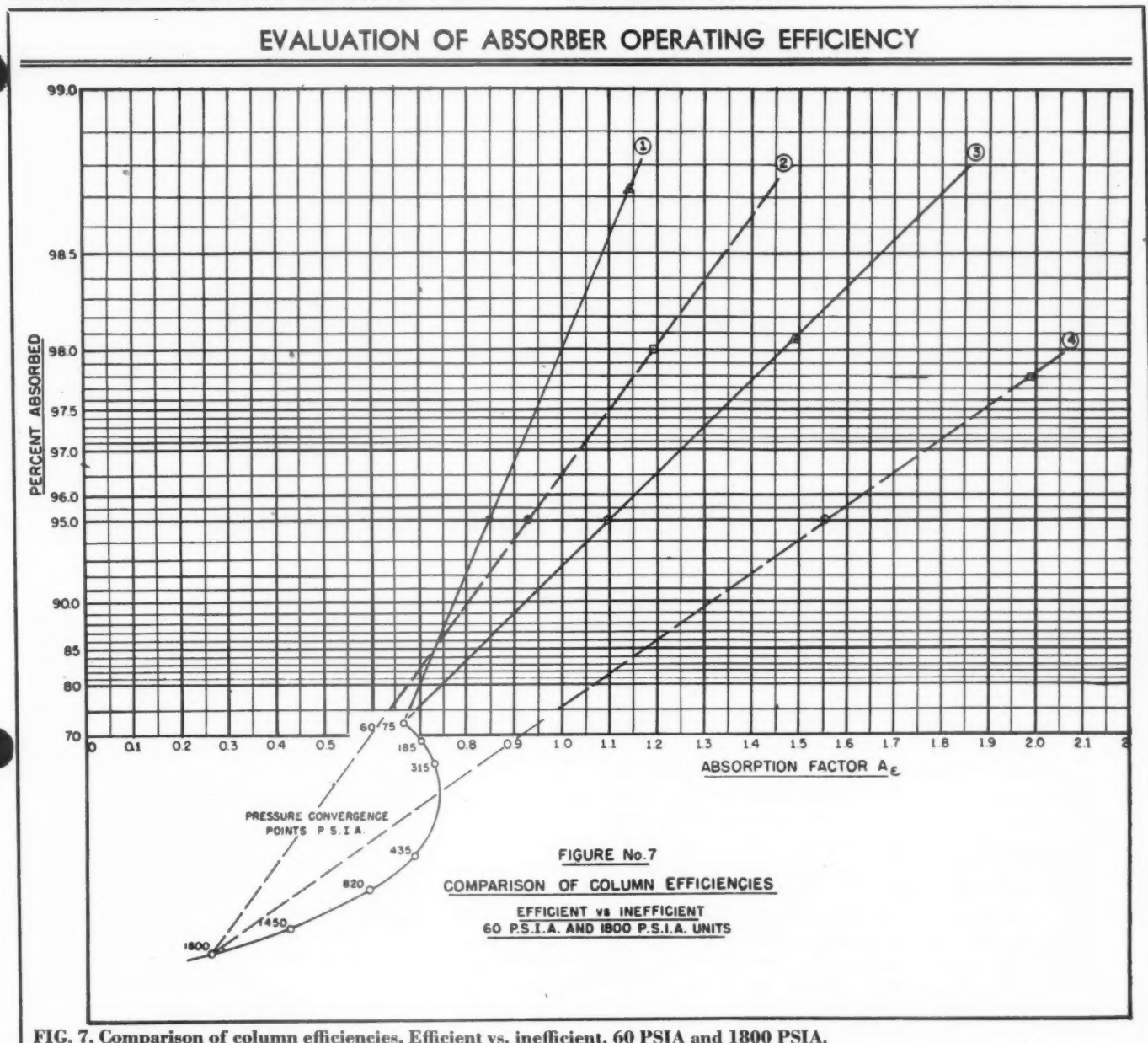


FIG. 7. Comparison of column efficiencies. Efficient vs. inefficient. 60 PSIA and 1800 PSIA.

We have previously mentioned the empirical nature of the pressure convergence points on the straight line chart. These points constitute an important feature of the chart, and their proper location is essential to the chart's accuracy. Although the present indicated locus of such points has been defined by three fairly large groups of data (averaging 67.5 lb per sq in. abs 435 lb per sq in. abs, and 1450 lb per sq in. abs, respectively), and four smaller groups, there is some question regarding the authority of a portion of this material. Consequently, we may find that the presently indicated convergence point locus will be subject to some change as additional authoritative data become available.

In connection with this locus, it will be noted that the individual pressure convergence points shift substantially with pressure. This shifting is in full agreement with another well understood absorption law, namely, that the absorption column's relative selectivity steadily decreases with increased pressure.

On Fig. 7 we have illustrated the operation of this law as applied to a pair of low and high pressure columns. In this figure, lines 1 and 2 represent two high efficiency units operating at 60 lb per sq in. abs and 1800 lb per sq in. abs, respectively, whereas lines 3 and 4 represent two similar pressured low efficiency units. For such pairs of columns (with each pair operating on the same quality lean oil and rich gas) the per cent nC_4 recoveries and relative lean oil rates associated with a common 90 per cent iC_4 recovery, are indicated thus:

Relative oil rates and nC_4 recoveries at 90 per cent iC_4 recovery.

	Per cent nC_4 recovery	Relative oil rate, per cent
60 lb per sq in abs:		
Efficient column	98.71	100
Inefficient column	98.07	130
1800 lb per sq in abs:		
Efficient column	98.00	100
Inefficient column	97.80	170

These figures not only indicate the differences in relative selectivity existing between high and low pressure columns, but also emphasize the importance to oil circulation of employing high efficiency column equipment, particularly for the higher pressure operations.

Taken from the article by E. G. Rogatz and J. A. Richardson in the January, 1947 issue of *The Petroleum Engineer*, pages 110 to 118, inclusive.

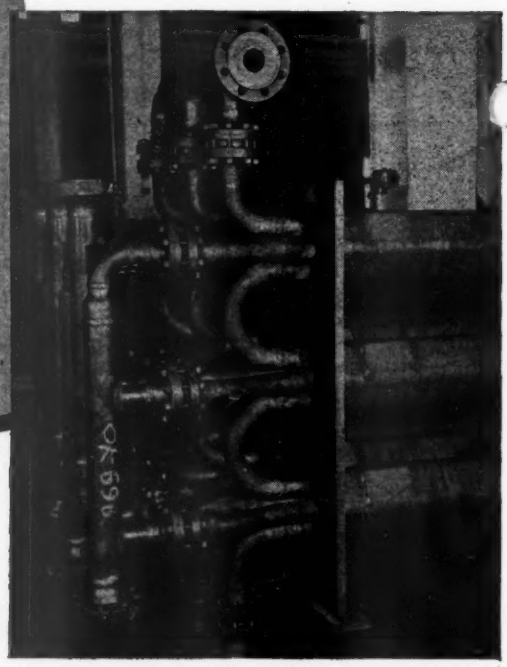
HEAT RECOVERY FROM

- Residuum
- Cracking Coil Tar
- Gas Oil
- Tar Bottoms
- Asphalt
- Clay-Bearing Oil

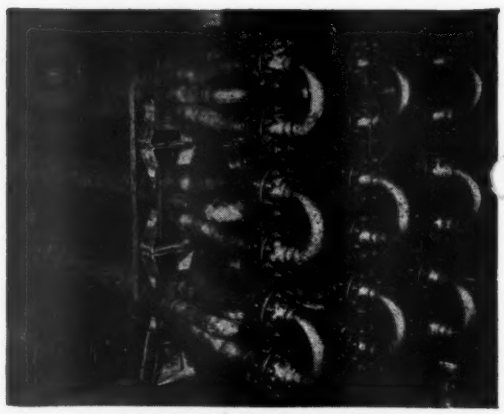
with maintained rated capacity

in the

G-R TUBEFLO SECTION



Front end of bank of G-R Tubeflo Sections showing pipe connections.



Rear end of bank of G-R Tubeflo Sections showing return bends.

More than 3500 installed units and over 18 years of service records have proven that this G-R heat exchanger does not clog when handling tarry or dirty fluids, and permits recovery of heat which formerly had to be wasted because no other type of heat transfer apparatus could withstand the severe operating conditions.

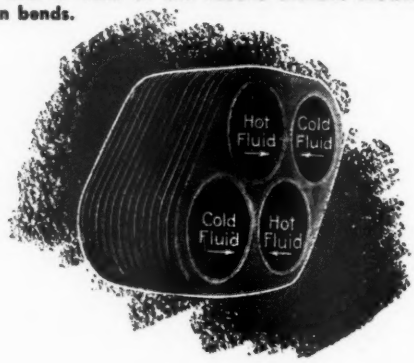
Fouling is prevented by its design that eliminates dead ends or pockets and provides continuously high velocity of fluids through passages of uniform cross-sectional area.

Internal leakage or contamination of fluids cannot occur because all joints are on the outside of the units.

Unequalled strength is provided by use of heavy gage tubes reinforced by closely spaced fins, permitting operating pressures up to 5000 psi.

If you have a high-temperature heavy or sediment-bearing fluid, the G-R Tubeflo Section will enable you to recover its heat effectively and economically. Bulletin 1621 describes this unit in detail, graphically shows its many distinctive features, explains several heat-saving applications, and quotes many service records. Write for your copy today.

In the G-R Tubeflo Section each fluid flows through two parallel tubes arranged in two passes. The four tubes of the Section are expanded into closely-spaced diamond-shaped fins which bind the four tubes together and transfer the heat from the hot tubes to the cold tubes. All pipe connections are at one end of the unit, and the return end of the unit floats freely on change in temperature. The Sections are standard and interchangeable, and any number of sections can be connected together in series or parallel to form a compact installation for the desired duty.



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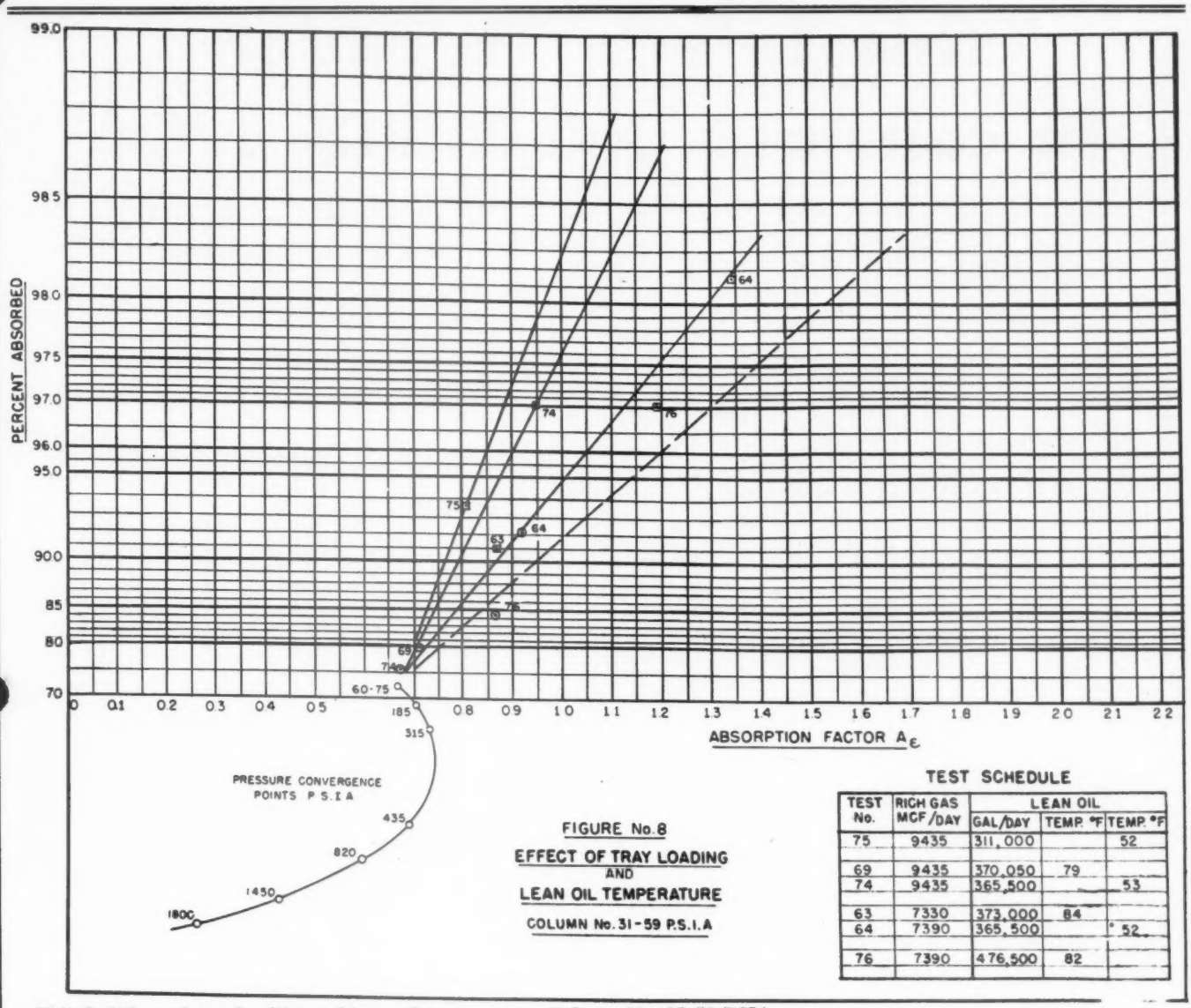


TEST SCHEDULE

TEST No.	RICH GAS MCF/DAY	LEAN OIL GAL/DAY	LEAN OIL TEMP. °F	TEMP. °F
75	9435	311,000		52
69	9435	370,050	79	
74	9435	365,500		53
63	7330	373,000	84	
64	7390	365,500		52
76	7390	476,500	82	

FIG. 8. Effect of tray loading and lean oil temperature. Column No. 31-59 PSIA.

The effect on the straight line operating curves of materially changing the lean oil temperature or tray loading at a given column is shown on Fig 8. Inspection of this figure (covering the operation of 59 lb per sq in. abs column) shows that the basic tray efficiency as measured by the slope of the operating line remained fixed for wide changes in lean oil temperature as long as the tray's physical loads were held substantially constant. On the other hand, substantial changes in the physical loading of the column resulted in corresponding changes in its basic tray efficiency.

In this clean-cut distinguishing between changes in physical tray action, and changes in lean oil temperature, the straight line chart thoroughly reflects good theory.

Typical examples of the straight line chart's characteristics are presented in Figs 4 and 5†, on which we have plotted the same data previously presented in rectangular charts Figs 2 and 3. Inspection of these latter plots shows that:

1. A majority of the operating lines on each plot can be drawn as straight lines through the indicated pressure convergence points with an accuracy well within that required for precise engineering practice.

2. Where there is a conflict in the test data, as between tests 33 and 32-41-42 of column 19, or tests 15 and 36 of column 13 (Fig 4) the "single convergence point" criteria immediately tells which particular test recovery value is in error.

3. Where there are several well defined lines of different slope for a given column, such as shown by tests 69 and 74 versus 63 and 64 for column 31 on Fig 4, or tests 38 versus 39 versus 30 for column 5 on Fig 5, a fundamental difference in basic tray efficiency is indicated.

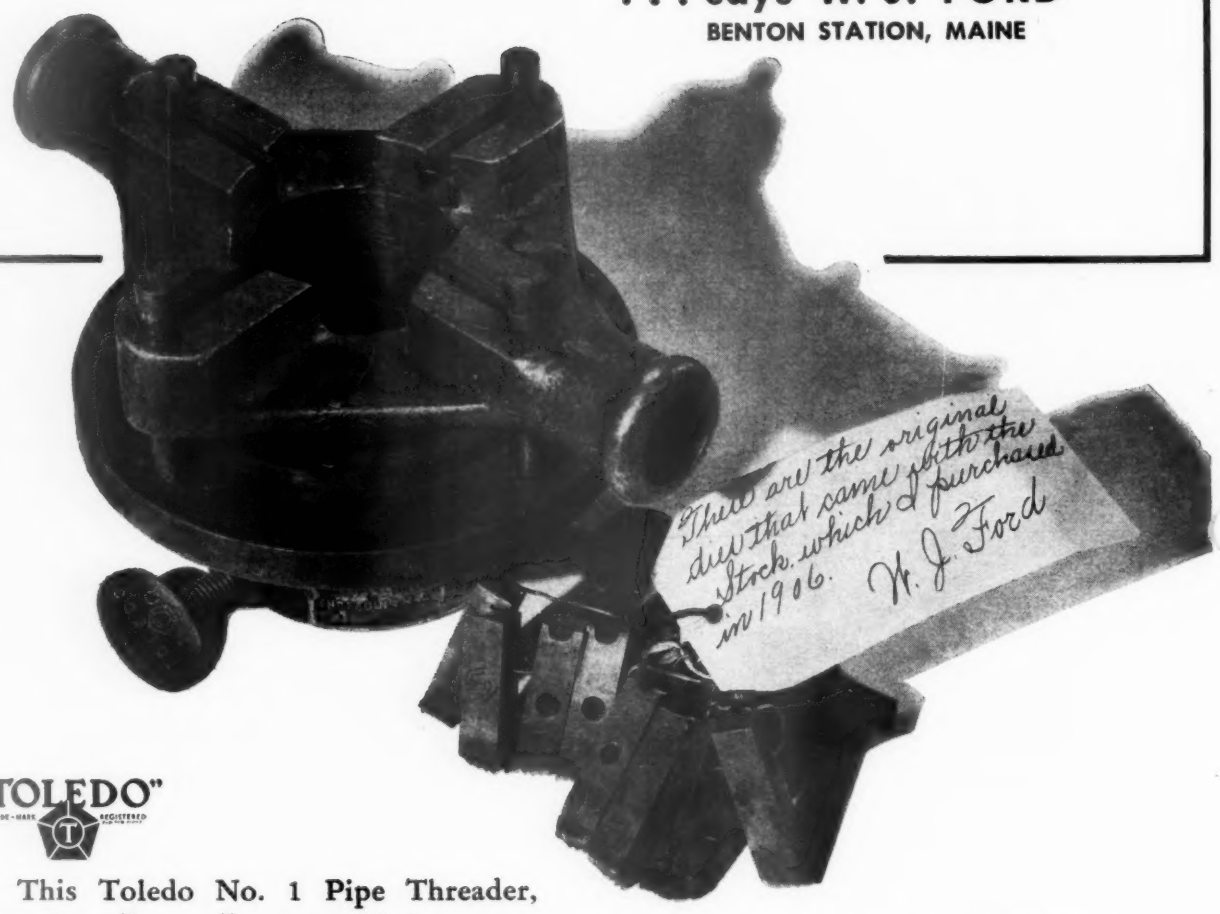
4. Operating lines that depart radically from the general operating pattern as with column 29 on Fig 4, or column 20 on Fig 5, definitely indicate serious error in the original test data.

†See sheets 4 and 5 in the February and March, 1947 issues of *The Petroleum Engineer*.

Taken from the article by E. G. Rogatz and J. A. Richardson in the January, 1947 issue of *The Petroleum Engineer*, pages 110 to 118, inclusive.

"This Toledo Threader in constant use SINCE 1906"

. . . says **W. J. FORD**
BENTON STATION, MAINE



"TOLEDO"

This Toledo No. 1 Pipe Threader, capacity 1″ to 2″, was sold by us on October 14, 1905, to a Boston distributor and purchased by W. J. Ford in 1906.

Mr. Ford says, "This stock was purchased in 1906 and has been in constant use ever since, but I cannot recall how many new sets of dies I have had to have in that time. *It has threaded pipe enough to reach three times around the world* and I am on the fourth lap now. When that is completed, I am going to retire and will ship the stock to you if you would like to have it to put on exhibition."

* * *

Today—the same basic principles of advanced design and quality construction keep Toledo Threaders the *preferred* tools of experienced mechanics everywhere! Get set with Toledo Threaders on *every* job—do it *better, faster* and *easier!* The Toledo Pipe Threading Machine Co., Toledo, O. New York Office, No. 2 Rector St. Bldg.

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PRECISION PIPE TOOLS

METHOD OF CALCULATING GAS FLOW AT CRITICAL VELOCITY

It is often necessary to determine the approximate volume of gas flowing through an opening such as a hole in a gas line, a blow-off on a gas line, or through a restricting orifice in a pipe, where the setting of a meter is not possible or desirable.

If the flow is through an orifice or nipple and velocity through it is at the maximum or "critical" rate, and the upstream pressure is known or can be determined, the approximate quantity of gas passing can be determined by the following simple formula:

$Q = D^2 P_1$.

Where:

Q = thousands of cu ft per hr at a pressure base of 14.9 psia, 60F temperature, and 0.60 specific gravity.

D = diameter of orifice or nipple, in.

P_1 = upstream absolute pressure.

For a 1-in orifice or nipple, Q is equal to P_1.

The effective diameter of an irregular opening, such as a regulator valve, can be determined approximately by the formula if velocity is critical and the upstream pressure and quantity of gas passing is known.

For gases with specific gravities other than 0.60, and when the flowing temperature is other than 60F, the quantity obtained by the above formula can be corrected by use of the regular multipliers for orifice meter measurement, or by the following:

Multiplier for specific gravity = $\sqrt{\frac{0.60}{G}}$,

where G is the actual specific gravity.

Multiplier for flowing temperature = $\sqrt{\frac{520}{T+460}}$,

where T is the actual flowing temperature.

Critical or maximum velocity is attained when the downstream absolute pressure is about 55 per cent or less of the upstream absolute pressure; or for practical purposes when the upstream absolute pressure is at least twice the downstream absolute pressure; or stated still another way, when there is a 50 per cent or more drop in pressure across the orifice or nipple.

When flow is from a vessel or pipe into the atmosphere, the pressure inside the pipe or vessel must be about 14 psig to create maximum or critical velocity through the opening. The upstream pressure for gas flow from a pipe or blow-off into the atmosphere can be obtained with a pitot tube inserted in the plane of the opening and in line with the center of the opening, as explained for use of the "Reid Open Flow Tables."* As the pitot tube converts velocity into the static pressure or head that causes the flow, the true upstream gauge pressure can be read from a pitot tube.

The derivation of the critical velocity formula is as follows:

The maximum or critical velocity that any gas can attain is equal to the velocity of sound in the gas. The velocity of sound in a gas varies:

(1) Directly as the $\sqrt{\text{ratio of specific heats}}$

(2) Directly as $\sqrt{\text{absolute temperature}}$

(3) Inversely as $\sqrt{\text{specific gravity}}$

The velocity of sound in air at 32F is approximately 1087 fps, and at 60F would be equal to:

$$1087\sqrt{\frac{520}{492}} = 1117 \text{ fps.}$$

The ratio of specific heats for air = 1.403.

The velocity of sound in any gas would therefore be equal to:

$$\frac{1117}{\sqrt{1.403}}\sqrt{\frac{K}{G}} = 943\sqrt{\frac{K}{G}},$$

where K is ratio of specific heats and G is specific gravity.

Assume a natural gas with a K value of 1.30, specific gravity of 0.60, at 60F:

V_s (velocity of sound) =

$$943\sqrt{\frac{1.30}{0.60}} = 1386 \text{ fps,}$$

which is the maximum velocity that the gas can attain.

Maximum velocity through an opening or outlet is obtained when:

$$\frac{P_2}{P_1} = \left(\frac{1+K}{2}\right)^{\frac{K}{1-K}} = R$$

Where:

P_1 = upstream pressure, abs,

P_2 = downstream pressure, abs, and

R = critical pressure ratio.

From the above formula, R = 0.546 when K = 1.30, and critical velocity is attained when the downstream absolute pressure is 55 per cent or less of the upstream absolute pressure. The static pressure of the jet (where the gas stream emerges from the opening) at critical velocity for the gas in question would be equal to 0.546 P_1.

Let:

Q_1 = cu ft of gas per hr at 14.9 psia pressure base,

C = coefficient or efficiency factor of opening,

A = area of opening, sq ft,

V_s = velocity of sound in the gas = 1386 fps,

P_1 = upstream absolute pressure, and

R = critical pressure ratio = 0.546.

Then:

$$Q = 3600\,CAV_s\frac{P_1 R}{14.9}$$

For a circular opening $A = \frac{\pi D^2}{4 \times 144}$

Where:

D = diameter,

$$Q = 3600\frac{C\pi D^2}{576} \times .1386 \times \frac{0.546\,P}{14.9}$$

$$= 999\,CD^2 P_1 \text{ cu ft per hr.}$$

If Q = M cu ft per hr, the 999 would cancel out, and

$Q = CD^2 P_1$ for 0.60 specific gravity gas in M cu ft per hr at 14.9 psia pressure and 60F temperature.

The efficiency factor C can be considered as being equal to unity for the practical purposes for which the formula is intended. A comparison of values from the formula with the maximum values given for both choke nipples and orifices in Deihl's *Natural Gas Handbook* will show close agreement. Values from the formula also agree closely with values given in the table "For Determining Open Flow of Gas Wells with Pitot Tube When Impact Pressure Exceeds 15 Pounds," by Walter Reid in 1929. It is known, of course, that no nipple or orifice would have an efficiency of unity, and that the actual efficiency would be less. The deviation of gas from Boyle's Law, however, has an offsetting effect, and the deviation is not taken into account in the formula.

For flows where P_1 is more than 500 psia the correction for deviation from Boyle's Law will have an appreciable effect, but not so much as would appear at first glance. At critical velocity the absolute static pressure of the gas stream is about one-half the upstream absolute pressure, regardless of how low the pressure drops after leaving the opening. The deviation correction, therefore, is applicable to about one-half the upstream pressure. Thus, if P_1 is 600 psia, the static pressure of the stream is about 300 psia, and the deviation correction for 300 lb should be applied. The direct deviation correction would be applicable, however, instead of the square root of the correction as in orifice meter measurement. The deviation factor for an average natural gas at 300 psia would be about 4 per cent.

The writer did some of the pencil work for Mr. Walter Reid* during the development of the open flow tables in 1928, and jotted down the formula given herewith. Having used it so many times for approximating gas flows under applicable conditions, it was thought that it might prove useful to some of the readers of *The Petroleum Engineer*.

★ ★ ★

*The late Walter Reid, former president of Southern Union Gas Company, who developed tables for the open flow measurement of gas wells, and also the Reid Method for testing vapor pressure of petroleum products.

Taken from the article "Workable critical velocity flow formula" by Roland O. Cox in the March, 1947, issue of *The Petroleum Engineer*, page 213.

10 ADVANTAGES

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When pipe includes *ALL* these advantages—as Republic Electric Weld does—you can be sure of ease of installation and dependable long life. More than 44,000 miles of Republic Electric Weld Line Pipe have given trouble-free service in the oil and gas industries during the past eighteen years—further assurance that you can specify it with complete confidence.

1. **Uniform Roundness**—Pipe ends match up perfectly—speed construction—cut costs.
2. **Uniform Diameter**—No "off-size" lengths to cause welding difficulties at joints.
3. **Uniform Wall Thickness**—Absolute dependability throughout every inch of length and circumference.
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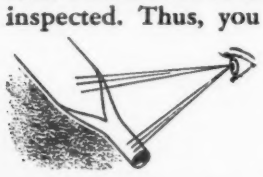
5. **Uniformly Straight**—Lengths line up evenly—go into the ditch freely.
6. **Easy To Bend**—High ductility steel makes bending in the field easy.
7. **Easy To Weld**—Low carbon steel welds readily—makes sound joints.
8. **Freedom from Scale**—Insures against clogged valves, contamination of petroleum products.
9. **Long Lengths**—Reduces number of joints—makes jobs move with longer strides.
10. **Inspected Inside and Out**—Republic Electric Weld Line Pipe is made from flat-rolled steel both sides of which are closely inspected. Thus, you are assured that the surface which becomes the inside wall when formed into pipe, is free from hidden defects.



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● **Jack Woodward,** formerly a petroleum engineer with Magnolia Petroleum Company at Alice and Dallas, Texas, has recently opened an office in the Republic National Bank Building in Dallas. He is president of Jack Woodward, Inc., a firm that is engaged in drilling and producing operations in various parts of Texas. In addition he is engaged in general consulting and is employed as a consultant by the Seeligson and La Gloria engineering committees.

Jack Woodward

● **Arthur F. Woods** has been appointed district sales manager by The Yale and Towne Manufacturing Company, Stamford Division ,to direct Tri-Rotor Pump sales in Michigan, Ohio, Indiana, Kentucky, West Virginia, and western Pennsylvania, it is announced by Ralph Thornburg, manager pump sales, Stamford Division. Woods' headquarters will be in Detroit, Michigan, where he will direct Tri-Rotor Pump sales for his district through Yale's petroleum and industrial representative and distributive organization.

• **Edgar A. Rogers,** Chattanooga Bank Building, Chattanooga, Tennessee, has announced the association with him of Chester A. Roush, Jr. Rogers' long-established business is the analysis of process plant requirements and the applications of equipment specifically engineered to meet special as well as ordinarily encountered operation conditions. Roush is a chemical engineering graduate of Georgia Tech who has recently returned from more than three years' duty with the U. S. Navy as a lieutenant.

● **Melvin H. Gertz,** formerly with Humble Oil and Refining Company, has joined the staff of Robert L. Purvin, consulting chemical engineers, 813-14 Southwestern Life Building, Dallas, Texas. Gertz graduated from the University of Texas, where he received the B. S. and M. S. degrees in chemical engineering. After graduation he served in both the laboratory and technical service divisions of the Humble Baytown refinery. With the Purvin organization, he will serve as a consultant in process engineering and control for the chemical and petroleum industries.

Melvin H. Gertz

● **Cecil E. Edwards** has been appointed field representative in the public relations department of U. S. Steel Corporation Subsidiaries, Southwest Division, Dallas. The district includes Texas, Oklahoma and New Mexico. Edwards, a native of Cisco, Texas, was graduated from Southern Methodist University in 1941 and was employed by Dun and Bradstreet, and by the *Dallas Journal*, prior to entering the Army Air Corps. He was appointed assistant manager of the Big Spring Chamber of Commerce last winter, a position in which he served until entering U. S. Steel.

● **James Worsdall,** previously with the Shell Group in Trinidad and Mexico, has returned to Latin America and established headquarters at the Hotel Granada in Maracaibo. He served in World War II in the Middle East as a major in the Royal Engineers. He expects to operate in Maracaibo as an engineer and contractor.

● **J. K. Wright, Jr.,** who has been acting director of the Mississippi Oil and Gas Engineering Committee since the Fall of 1946 when Alex Crowell resigned to accept a position with the Oil and Gas Division of the U. S. Department of the Interior, has been elected director for the coming year. This action took place at the annual membership meeting held April 25.

J. K. Wright, Jr.

Wright is a native of Oklahoma, his early education was obtained in the schools of Oklahoma City and he received a degree in petroleum engineering from the University of Oklahoma. He began his work with the Phillips Petroleum Company in Oklahoma City in the early spring of 1936 and for the next seven years worked in various parts of Oklahoma, New Mexico, and Kansas for this same company. On June 1, 1943 he became affiliated with the McAlester Fuel Company as production engineer and until the first part of 1945 worked continuously in southern Arkansas. Since the inception of the Mississippi Oil and Gas Engineering Committee during the early part of 1945 Wright had been employed as chief engineer until the fall of 1946 at which time he was elected acting director.

● **C. W. Main** has been appointed a field representative of the Plomb Tool Company. He makes his headquarters in Denver, and his territory includes Colorado, Wyoming, and parts of South Dakota and Nebraska. He serves under J. J. Buhler, regional sales manager.

● **W. W. Keeler** has been elected vice president, Refining Department, of Phillips Petroleum Company. He succeeds the late W. G. Hiatt who died April 12. Keeler has been manager of the Refining Department since October, 1945; he was assistant to the vice president in 1944, and technical assistant to the vice president in 1943. His election as the company's newest vice president is the culmination of a 16-year career in the Phillips Refining Department. At various times he worked at the Kansas City and Borger refineries as a chemist, control chemist, process engineer, chief chemist, night superintendent, assistant manufacturing superintendent, and chief process engineer.

W. W. Keeler

● **Justus W. Lehr** has been appointed district manager in charge of the ACF Berwick, Pennsylvania plant, of American Car and Foundry Company, succeeding **Guy C. Beishline** who recently resigned. Lehr was born in Mansfield, Ohio and was educated in the public schools of Chicago. Before joining ACF in 1940 he had been employed by the Pullman Company, Mt. Vernon Car Company, Curtis Bay Copper Iron Works of Baltimore, Maryland, and the Sanford Day Iron Works at Knoxville, Tennessee. With ACF he has served as assistant district manager of the ACF Berwick, Pennsylvania, plant during the company's wartime expansion and was employed in that capacity until the time of his transfer as head of the ACF Chicago, Illinois, plant in December, 1944.

● **Doyle D. Buttolph** has been appointed manager of the Mechanical Equipment Division. When he received his degree in mechanical engineering in 1940 from Iowa State College, Buttolph joined Phillips Petroleum Company as a senior draftsman. In April, 1941, he became acting district manager of the company's tank car division in Bartlesville and was later transferred to the engineering department. Buttolph was granted a military leave of absence in 1942. Upon his return to Phillips he was assigned to the Chemical Products Department as assistant manager of the Engineering and Equipment Division, and assumed his present position of manager on February 15 of this year.

D. D. Buttolph

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FLAME arrester valve plates have as many as 140 holes to the square inch. When these pin-point holes are allowed to become clogged with carbonaceous deposits operating efficiency of arresters must drop.

You can quickly restore these plates to full breathing efficiency by soaking them in a solution of a recommended Oakite cleaning compound. Oakite heavy-duty cleaning penetrates the tough, clogging deposits, softens them for fast removal by brushing. Hose-rinsing cleans both plate surfaces and holes thoroughly. There is no danger of etching copper plates.

This Book Helps Save Time and Money

88 different time-saving cleaning and related procedures are detailed in the new Oakite Petroleum Digest. Save hours and dollars by writing NOW for your FREE 28-page copy. No obligation.

OAKITE PRODUCTS, INC.
48 Thames Street, NEW YORK 6, N. Y.
Technical Representatives in Principal Cities of U. S. & Canada

OAKITE

Specialized Industrial Cleaning
MATERIALS • METHODS • SERVICE

● **Joseph T. Cashman,** until recently an attorney for the Shell Oil Company, has been appointed administrative assistant to **D. B. Hodges,** New York vice president, transportation and supplies.

● **A. E. (Al) Collins,** manager of purchasing and stores, Los Angeles, on April 1 completed 35 years of service with the company. S. F. Bowlby, vice president, Los Angeles, celebrated the occasion by presenting Al with a service emblem pin with three diamonds. Al started his Shell career in 1912 with the California Oilfields, Ltd., which was later purchased by the Shell Oil Company. He has one of the longest service records in the company, most of which has been in the field of purchasing and stores.

● **C. R. (Red) O'Dell** has been named manager of the West Texas division of Tuboscope Company with headquarters at Odessa, replacing C. E. Luna who is on leave of absence from the company. O'Dell has been with Tuboscope for several years, in Oklahoma and Kansas, and more recently as manager of the company operations in Mississippi with headquarters at Natchez.

C. R. O'Dell

● **Jack W. Askins,** who joined the New York office of the American Iron and Machine Works Company last October after 56 months service in the armed forces, recently made a month's tour of the Mid-Continent oil fields studying equipment developments. He plans an extended tour of European oil fields soon.

● **Henderson Supplee, Jr.,** president of the Supplee-Wills-Jones Milk Company, has resigned that post to become a vice president of The Atlantic Refining Company. He assumed his duties with the company May 6.

● **Robert R. Dreisbach** of the staff of the physical research laboratory of The Dow Chemical Company, Midland, Michigan, recently was presented a silver medal by the Hyatt Award Committee for his achievement in the plastics industry in 1946. Dreisbach received the silver medal in recognition of his contribution to the development of styrene. He and **Dr. John J. Grebe,** director of Dow Chemical Company's physical research laboratory, who was awarded a gold medal and $1,000, received this recognition of their achievements at ceremonies following dinner in the Hotel Statler, Detroit, Michigan.

● **E. R. Queer** and **E. R. McLaughlin,** both of Pennsylvania State College, have been retained by Pittsburgh Lectrodryer Corporation as consulting engineers in the fields of solid adsorption, dehumidification, and allied fields. Queer is professor of engineering research in charge of Penn State's thermal research laboratory. McLaughlin is assistant professor of engineering research at the college.

● **James A. Stahn** has been added to the staff of Young Radiator Company, Racine, Wisconsin, as engineering representative. Stahn will be connected in a sales engineering capacity particularly for aircraft heat transfer products and will also contribute to the engineering, research, and production of heat transfer equipment for gas turbines and other developments.

J. A. Stahn

Stahn joins Young Radiator Company with a wide and varied background of experience in the Heat transfer field. Graduated from Purdue University in 1941 with the degree of B.S.M.E., he entered the Army Air Forces in September, 1941. Under the AAF training program his formal education was continued at the University of California where he received his master's degree in mechanical engineering in 1946. With this exception, the remainder of his tour of duty was spent at Wright Field, Dayton, Ohio. Here he worked with cooling and lubricating problems for all AAF Aircraft. This included work with both liquid and air-cooled engines in addition to heat transfer for turbo-jet and turbo-prop engines.

● **Brison Wood** has been elected treasurer of the Minneapolis-Honeywell Regulator Company, Harold V. Sweatt, president, announces. Wood succeeds Willard L. Huff, who has been serving as executive vice president and treasurer. Huff will continue to serve as a director and executive vice president.

● **J. G. Tolpin,** formerly with Universal Oil Products Company, has been appointed to the new position of editor of foreign technical information in the development and patent department of Standard Oil Company (Indiana). He will study foreign scientific and technical publications and report on matters of interest to the company in connection with its expanded development and research program.

● **James M. Stover,** foreman of the light oils inspection laboratory at the Whiting refinery of Standard Oil Company (Indiana), has retired on company annuity after more than 49 years' service. **B. J. Orr,** assistant foreman of the light oils inspection laboratory, has succeeded him.

In September of 1897 Stover joined Standard as telephone operator in the one-room laboratory at Whiting. In 1898 he became a sample boy in the laboratory at Whiting and two years later was made night inspector. He was transferred to Standard's refinery at Sugar Creek, Missouri, in 1904, to help establish an inspection laboratory, and after three years there returned to Whiting. In 1921 he became foreman of the Whiting light oils inspection laboratory, the position he held until his retirement.

● **Garth L. Young,** chief engineer, was recently elected vice president of the Signal Oil and Gas Company. Young has for some time been a vice president and director of Signal Oil Company, the company's marketing subsidiary, but now serves as vice president and director of the parent company as well.

● **Hubert Guyod,** well logging consultant, of Houston, Texas, was the guest speaker at the regular program meeting of the Petroleum Engineering Club (A.I.M.E. Student Affiliate) of Texas A. & M. College held on April 25. Guyod spoke before geology and petroleum engineering students on the principles of the electric log and its application in the petroleum industry.

● **A. B. Reese, Jr.,** has been appointed regional sales manager at Fort Worth, Texas, of the Superior Engine Division of The National Supply Company, according to an announcement by Robert M. Pearson, sales manager of the division. Reese, an engineering graduate of Ohio State University, has been assistant chief engineer of the division's Springfield, Ohio, plant.

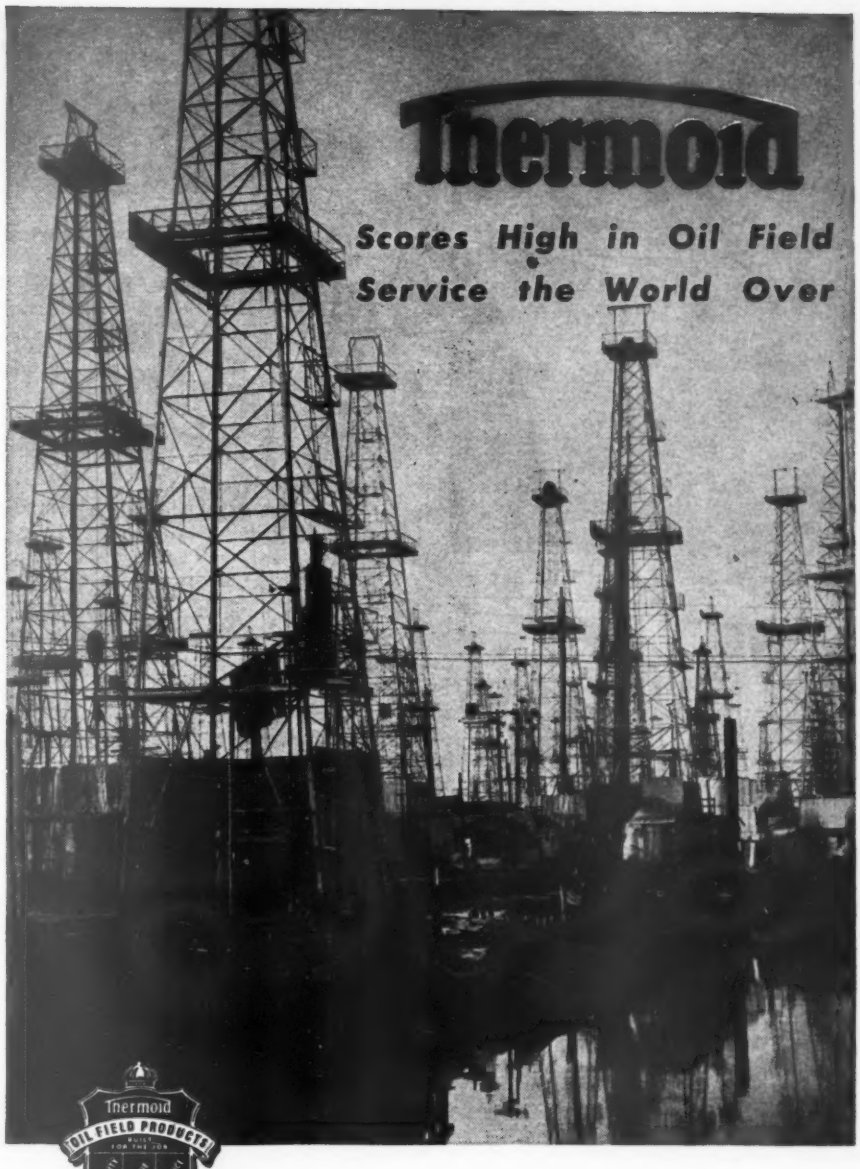
A. B. Reese, Jr.

● **Hal B. Williams has been named** process products engineer in charge of sales of specialized petroleum products for industrial use in the Washington division, by General Petroleum Corporation. With his new headquarters in Seattle, Williams recently moved to that city from Tacoma.

● **Dave S. Ferree** was recently appointed district manager of the new Philadelphia sales office of The Falk Corporation. His territory includes the Pennsylvania and Delaware areas formerly handled by Martell and Ferree and the York, Pennsylvania, area, which was managed by the late John Ericson. The Philadelphia offices of the Milwaukee plant are at 505 Race Street.

● **G. W. Holbrook,** of Bradley Producing Corporation, Wellsville, New York, has been named chairman of the production research advisory committee of the Pennsylvania Grade Crude Oil Association. He succeeds **Wilson K. Page** of Olean, New York, who resigned.

● **J. C. Ballagh,** vice president and general manager of Patterson-Ballagh, division of Byron Jackson Company, Los Angeles, departed New York via Pan-American Air Lines April 15, for a six weeks' business trip in England and on the continent. Jack plans to spend about four weeks in England and will make his headquarters at the office of H. F. Towler, 9 Cavendish Sq., London W1, England. Later he will go to France to plan and discuss future business in the development and uses of oil field rubber specialties, for which Patterson-Ballagh is noted. He is expected to return to the United States the latter part of June.



There are common sense reasons why Thermoid's complete line of rubber products and friction materials for Oil Field equipment sees service in all parts of the world . . . wherever oil is handled.

There is a definite economy and convenience to the buyer—since a single source of supply furnishes the entire line.

There is the assurance that high quality standards are rigidly maintained in products sold under the Thermoid trade mark. And finally—there is a convenient warehousing and shipping set-up that saves precious time when articles are needed in a hurry.

Thermoid serves the world-wide Oil Industry with the products listed below.

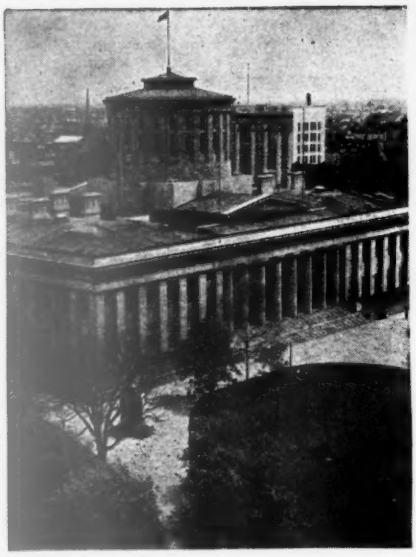
THE THERMOID LINE

Includes: **Rotary Brake Blocks • Woven Oil Field Brake Lining • Packings • Rotary Hose • Slush Pump Hose • Flexible Discharge Unit Hose • Production and Refinery Hose of All Types • V-Belts and Drives • Oil Country Belting • Stuffing Box Rings • "No Wip" Line Saver • Wire Line Turn Back**

Thermoid Products

AUTOMOTIVE • INDUSTRIAL
OIL FIELD • TEXTILE

THERMOID COMPANY, TRENTON, N. J., U. S. A.
Warehouses in Houston, Los Angeles, Chicago



OHIO STATE CAPITOL BLDG., COLUMBUS

LONG LIFE QUALITY

Pleases Ohio Cities and Industries

Ohio, famed state of thousands of great industries and many prosperous and progressive cities now has in operation over 650 Layne high efficiency Well Water Systems. These Vertical Turbine systems are distinguished by their outstanding engineering features, extraordinarily high quality and absolute dependability in providing years and years of service.

Layne Well Water Systems are world famous for low operation cost. Furthermore they are so sturdily built and correctly installed that little or no upkeep expense is necessary.

For nearly 70 years Layne has pioneered in Well Water Systems and Vertical Turbine Pumps. No other make, in all the world compares with their high standards of perfection.

For further facts, catalogs, bulletins, etc., address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tennessee.

PUMPS For

Wells—Lakes—Rivers—Reservoirs—Irrigation Projects—are obtainable in sizes from 40 to 16,000 gallons per minute, powered by electric motor, V-belt or angle gear drives. Write for Pump Catalog.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minn., Minneapolis, Minn. ★ International Water Supply Ltd., London, Ont., Can. ★ Layne-Hispano Americana, S. A., Mexico, D. F.

Cowboy: Getting your saddle on backwards, aren't you?

Dude rancher: That's all you know about it, smarty. You don't even know which way I'm going.

* * *

Jack (in Alaska): Why don't you wear earmuffs?

Bill: I haven't worn 'em since the accident.

Jack: What accident?

Bill: Someone asked me if I wanted a drink—and I didn't hear 'em.

* * *

Binks: What's Mable mad about?

Spinks: I understand she stepped on one of those scales with a loud speaker attachment and the thing called out, "One at a time, please!"

* * *

Captain: Honey, how do you like my company?

Gal: Swell, every one of them.

* * *

Boy (at Barber's): I want my hair cut just like my father's—with a hole in the middle.

* * *

Father: Don't you think our son got his intelligence from me?

Mother: He must have — I still have mine.

* * *

The landlady brought in a plateful of extremely thin slices of bread, which rather dismayed her hungry men boarders.

"Did you cut these, Mrs. Brown?" asked one.

"Yes, I cut them," came the stern reply.

"All right," went on the boarder, "I'll deal."

* * *

"Honey, aren't all these bills for the clothes you bought before we were married?"

"Yes, my sweet."

"But don't you think it's unfair to ask a fish to pay for the bait he was caught with?"

* * *

Father: My boy, I never kissed a girl until I met your mother. Will you be able to say the same thing to your son?

Son: Yes, father—but not with such a straight face.

* * *

Policeman: You can't park in front of that fire hydrant.

Motorist: Why not? The sign says, 'Fine for parking.'

* * *

Housewife: Look here, Nora, I can write my name in the dust on the table.

Nora: An' sure, ma'am it must be wonderful to have an education like that.

"Was your uncle sensible until the last?"

"I won't know until his will is read tomorrow."

* * *

Seasick Professor (on friend's yacht): I say, what about going back; after you've seen one wave, you've seen them all.

* * *

A Westerner entered a saloon with his wife and three-year-old boy. He ordered two straight whiskies.

"Hey, Pa," said the kid, "ain't mother drinking?"

* * *

There he was — the Scotchman who was pummeled nearly to death because he thought the sign on the door read "Laddies."

* * *

A hillbilly built a house for his wife in which he fashioned windows but no doors.

Nervous Bride: Where are the doors?

Hillbilly (drawing himself up to his full height): Doors? Are you going somewhere?

* * *

And there's the story about the man who spent a lot of money to rid himself of halitosis, only to find that his friends didn't like him anyway.

* * *

A young girl, seeing names like "Surrender" and "My Sin" on the perfume counter, timidly asked, "Don't you have anything for a beginner?"

* * *

Toast overheard at a fraternity banquet: "Here's to the land we love, and vice-versa."

* * *

Then there's the story about the Scotchman who spanked his children and put them out in the flower bed to cry.

* * *

"I hear," he said hopefully, "that you have a propensity for petting."

"A dirty lie!" she cried. "All I have is a davenport."

* * *

George: They say you can tell a girl's character by her clothes.

Jackie: Oh, come now. Surely they have more character than that.

* * *

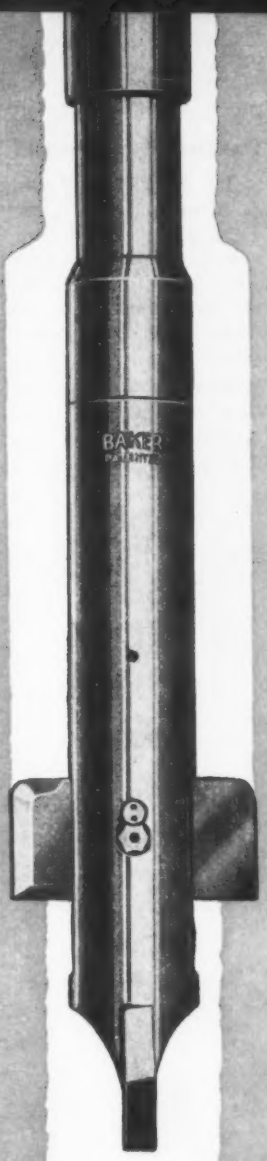
Then there was the fellow who rode in a cab with his girl. She was so beautiful he could hardly keep his eyes on the meter.

* * *

"Remember, darling, last night you said there was something about me you could love?"

"Yeah, but you spent it all."

It "scrapes for a living"... and always "comes out on top"



The BAKER WALL SCRAPER has many important uses in modern drilling.

When it is desirable to enlarge the diameter of an open hole to an extent considerably greater than the diameter of the casing, you can depend upon this strong, safe Wall Scraper with blades which open positively when pump pressure is applied. The uncased hole can be *enlarged at any point,* and by changing to progressively larger sizes of blades, an amazingly increased diameter can be secured. For example, the No. 6 Scraper can be run safely through 9⅝" API casing, and then will ream from a minimum of 9¼ inches to a maximum of 19 inches by changing to increasingly larger sized blades.

RUGGED BLADES CLOSE SAFELY

Baker Wall Scraper blades have extra-long vertical cutting edges which prevent any tendency to "corkscrew" and insure scraping the maximum footage of full-gauge hole. And, when the scraper is to be removed from the hole, a strong plunger spring closes the blades into the body. These blades are made from special alloy steel forgings, and their cutting surfaces are hardfaced and set with Tungsten Carbide inserts to insure long cutting life.

IMPORTANT NEW IMPROVEMENT

The new Baker Model "D" Wall Scraper PLUNGER ASSEMBLY does not include the circulation screen previously used, and this simplified design provides far longer life of these parts, and also greatly reduces wear on the wall scraper body caused by fluid cutting.

BAKER OIL TOOLS, INC.

Houston · Los Angeles · New York

These typical uses illustrate a few of the many worthwhile applications of the Baker Rotary Wall Scraper.

Figure 1—WATER SHUT-OFF TESTS are made after rat-holing below the shoe, "wall scraping" for a vertical distance of 5 feet or more to the gauge of the original hole (or slightly beyond). Figure 2—ENLARGING HOLE TO SET CASING OR LINER with maximum ease and safety. Figure 3—REMOVING MUD SHEATH from the face of the formation to permit cement to bond with original formation. This same procedure is used to scrape the face of the oil sand to increase production. Figure 4—BOTTLENECKING to insure complete encasement of the shoe joint with cement; also to minimize hazard of channeling at this vital point. Figure 5—ENLARGING HOLE FOR C.P. JOB—showing "bottlenecked" section with casing or liner serving as water string above, and oil string below, the cementing point. Figure 6—GRAVEL PACKING is easily and effectively performed when the hole has been enlarged with a Baker Rotary Wall Scraper.

BAKER

ROTARY HYDRAULIC EXPANSION

WALL SCRAPER

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Opens Beaumont store

The Bethlehem Supply Company announces the opening of its new store at Beaumont, Texas. Supplementing the normal production and drilling equipment inventories in Bethlehem stores, the Beaumont store will carry a complete stock of refinery and chemical plant supplies in order to serve the maintenance and expansion needs of those industries in the Beaumont-Port Arthur area.

R. C. Repp has been named store manager and field representative. He has been with the Bethlehem Supply Company at Houston since 1944, having previously been employed by the Houston Shipbuilding Company.

R. C. Repp

A. V. Wafer

A. V. Wafer has been named special representative at Beaumont, to handle refinery supplies. He is a graduate mechanical engineer and has previously been associated with the Penn Shipbuilding Company at Houston and The Texas Company at Port Neches prior to his joining the Bethlehem organization in November 1946.

This store is a new addition to Bethlehem's Gulf Coast District under the general supervision of O. H. Crowe, district manager at Houston.

Heads Venezuelan firm

E. D. Hall, drilling and production engineer, has been elected president of Weatherford Spring Company of Venezuela, Inc., and took over his duties at the head office in Caracas on May 1. He will be responsible for Weatherford operations in all South American countries. The Venezuelan firm is an associate company of the Weatherford Spring Company of Weatherford, Texas, manufacturers of spiral centralizers and reversible scratchers and other tools used in oil well completions.

E. D. Hall

Associated with Hall in Venezuela is Roland Smith, export representative of the Weatherford company. J. E. Hall, Sr., owner of the Weatherford Spring Company of Texas, has just returned to the United States after an extended stay in Venezuela, to resume supervision of domestic engineering activities.

Lay gathering lines *fast*

DAY OR NIGHT . . . RAIN OR SHINE

You don't have to stop for rain or darkness when you join your gathering lines with Dresser Couplings. Easily installed by any workman . . . the only tool needed is a wrench. No spark or fire hazard. Especially suitable for temporary lines because most of the interchangeable parts can be salvaged. Get Dressers from your oilfield supply store or our Houston warehouse.

Write for Oil Fields Catalog, Form 4012

DRESSER STYLE 38 COUPLINGS

ONE OF THE DRESSER INDUSTRIES

Dresser Manufacturing Division, Bradford, Pennsylvania
Houston Warehouse, 1121 Rothwell St., Houston, Texas

Texasteel general manager

J. R. Mooney was recently appointed general manager of Texasteel Manufacturing Company, Fort Worth, Texas, makers of electric steel sucker rods and other sub-surface equipment. To take the Texasteel post, Mooney resigned as manager of one of the world's largest firms of inspection and consulting engineers. He is an actime member of the A.I.E.E., A.R.E.A., A.S.T.M., A.P.I., the Iron and Steel Institute, the American Society for Metals, and the Western Society of Engineers, and is a past secretary and director of the Chicago Engineers Club.

J. R. Mooney

As a mechanical and metallurgical engineer with broad U. S. and foreign experience in equipment development, manufacturing production problems, and industrial research, Mooney is directing Texasteel's program to improve the design of oil-well pumping equipment.

Ed Wood passes

E. B. (Ed) Wood, 46, sales engineer for the Wyatt Metal and Boiler Works, Houston, Texas, for the last 13 years, passed away April 18 at his home in Houston. Burial was in Fort Worth, his birthplace.

E. B. Wood

Wood attended college in Canada and served as an aviator in World War 1. Prior to joining the Wyatt organization he was connected with the Imperial Oil Company and the Parkersburg Rig and Reel Company in Venezuela and Colombia. He was an active member of the Houston Engineers Club and the Houston Chapter of Nomads.

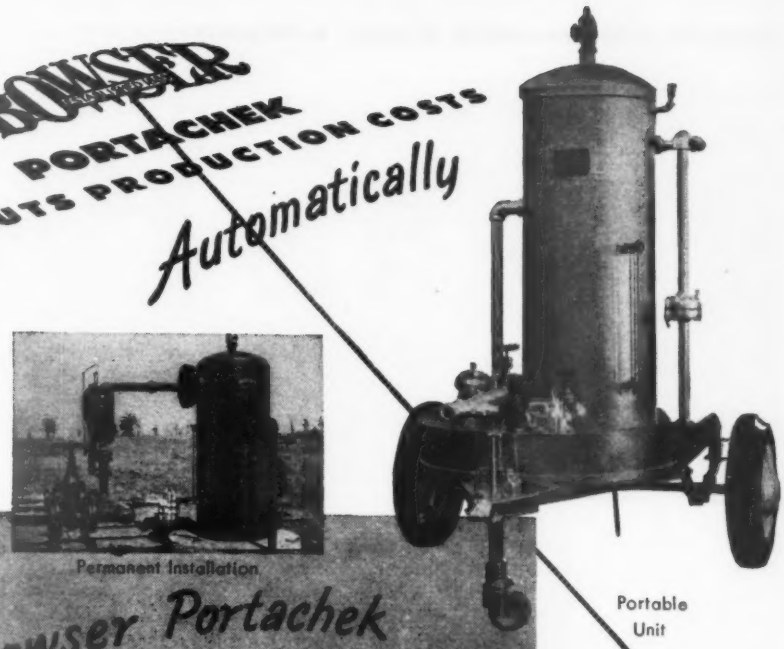
New BS&B branch

Black, Sivalls and Bryson, Inc., Kansas City, Missouri, has consolidated its oil-field equipment operations in Mississippi in the newly opened branch at Brookhaven. Ted Falls, manager of the recently closed Natchez branch, and Tom R. Sessums, will operate the Brookhaven branch.

Three recent shifts have been made of Black, Sivalls and Bryson, Inc. branch managers. Ed Poole, who has been manager at Salem, Illinois, has been sent to the Odessa, Texas, branch. Harrell Bruner, formerly of Carmi, Illinois, has moved to the Salem spot, where he will assume the managership. Andy Shaw has been sent from Oklahoma City to direct the Carmi, Illinois, branch.

BOWSER

PORTACHEK CUTS PRODUCTION COSTS Automatically



Permanent Installation

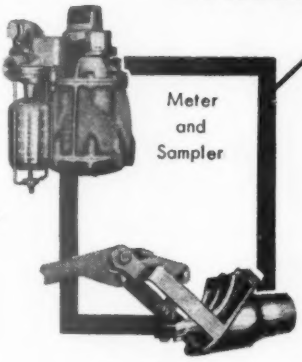
Bowser Portachek

Portable Unit

1 ELIMINATES GAUGE TANKS
2 STOPS EVAPORATION LOSSES
3 REDUCES PUMPING AND TRANSPORTATION COSTS
4 MINIMIZES FIRE HAZARDS
5 FURNISHES TRUE PROPORTIONAL SAMPLE
6 PROVIDES PERMANENT, INDISPUTABLE RECORDS
7 ACCURATELY RECORDS GROSS PRODUCTION
8 DETECTS SLEEPERS OR WET WELLS

PORTACHEK COMBINES THESE PROVED WELL-CHECK UNITS...

- Bowser Special Oil Well Xacto Meter
- Bowser True Proportional Sampler
- Bowser Spill-Proof Gas Trap with patented Peel-Off Valve—no packing glands—no valves to grind or adjust.



Simplified gas and oil control valve (Patented)

BOWSER WELL-CHECK SYSTEMS ARE ENGINEERED TO HANDLE ANY TYPE OF OIL WELL PRODUCTION

Portachek provides an accurate, dependable method for checking the potential production of new wells before installing permanent equipment.

Write today for complete information on Bowser equipment for modern oil fields.

BOWSER, INC.
1329 CREIGHTON AVENUE, FORT WAYNE 2, INDIANA

Liquid Control Specialists Since 1885

Annual sales meeting Happy Company

The accompanying photograph was taken at the annual sales meeting of The Happy Company, Tulsa, Oklahoma. Seated left to right: Roy Lindley, secretary-treasurer and office manager, Tulsa; Jean Luelf, billing, Tulsa; W. H. Gorey, inventories, Tulsa; Paul E. Mahaffey, president, Tulsa; Mertyce Swanson, stenographer, Tulsa; Wiley T. Swearengen, buyer, Tulsa; Leo C. King, vice president in charge of sales, Tulsa; standing left to right: Bob Meek, sales engineer, Tulsa; Mabel Tidmore, bookkeeper, Tulsa; Bill McCracken, branch manager, Odessa, Texas; Cecil White, store manager, Tulsa; Jimmy Allen, branch manager, Salem, Illinois; Ed Allan, North Oklahoma representative, Tulsa; Cotton Rundle, branch manager, Seminole, Oklahoma; Bob Miller, branch manager, Wichita and Ellinwood, Kansas; Jack Mills, store manager, Salem, Illinois; Ben Shelton, representative for East Texas, Arkansas, Louisiana, Mississippi, Kilgore, Texas; Orville Smith, sales engineer, Tulsa; Charley Kitch, representative for North Texas, South Oklahoma, Wichita Falls, Texas; Bus Williams, store manager, Seminole, Oklahoma; John Ritter, sales engineer, Odessa, Texas; Otis Osborn, auditor, Tulsa, and Rowdy Robson, sales engineer, Tulsa.

Plant enlargement

Elmer Nooter, president of the John Nooter Boiler Works Company, St. Louis, Missouri, has announced a $300,000 expansion program to increase the plant's size and production more than 30 per cent. Construction will begin immediately and will be completed next fall.

E. L. Berry succumbs

Death resulting from heart attack claimed E. L. ("Bill") Berry on April 3, at the age of 52. Berry was Link-Belt vice president in charge of production. with headquarters in Chicago.

E. L. Berry

Berry began his Link-Belt career in 1914, as machinist, at the company's Pershing Road plant in Chicago, after having been graduated from Williamson Trade School, and successively held the positions of rate setter, sub-foreman of shop, head of time study department, works engineer, general superintendent, and assistant general manager.

During the war, Berry was vice president and general manager of the wartime subsidiary Link-Belt Ordnance Company, now dissolved.

He became vice president of the parent organization, Link-Belt Company, on January 1, 1944. He was also a vice president and director of Link-Belt Speeder Corporation.

VICTOR
Custom
FASTENINGS
The manufacture of custom fastenings from any material to any specifications has been our business for 34 years.
VICTOR Studs and Bolts are made to your specifications of strength and resistance to corrosion and heat. May we quote on your requirements?
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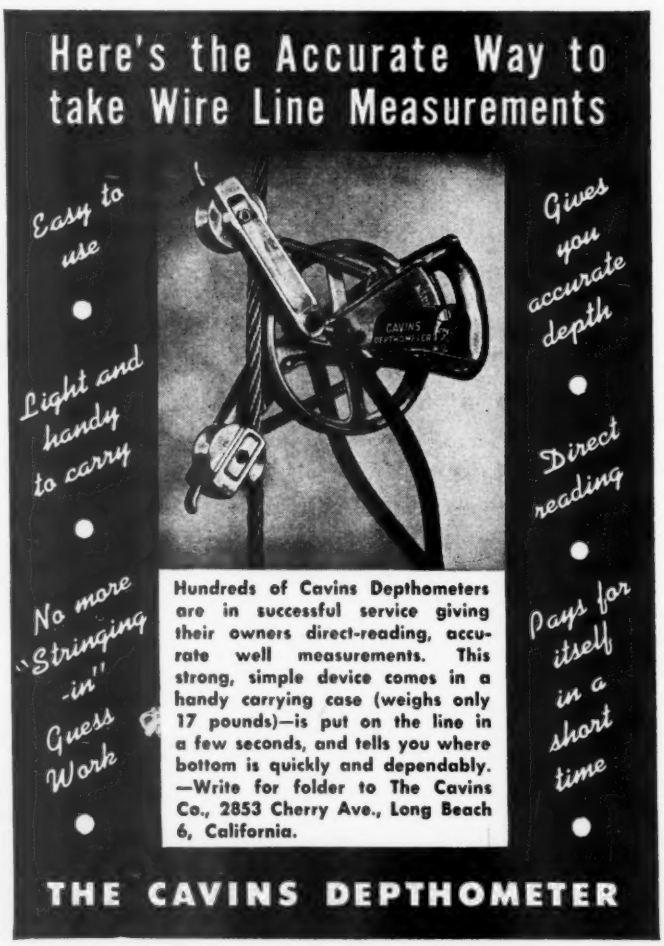

Here's the Accurate Way to take Wire Line Measurements
Easy to use
Light and handy to carry
No more "Stringing-in" Guess Work
Gives you accurate depth
Direct reading
Pays for itself in a short time
Hundreds of Cavins Depthometers are in successful service giving their owners direct-reading, accurate well measurements. This strong, simple device comes in a handy carrying case (weighs only 17 pounds)—is put on the line in a few seconds, and tells you where bottom is quickly and dependably. —Write for folder to The Cavins Co., 2853 Cherry Ave., Long Beach 6, California.
THE CAVINS DEPTHOMETER

Thermoid appointments

Announcement by the Thermoid Company of the appointment of Henry E. Holden and Louis Benton as original equipment sales engineers for industrial friction material has been made at Trenton, New Jersey, by H. W. Overman, manager of industrial friction materials.

H. E. Holden

Holden will operate in the Michigan and Ohio area with headquarters at 17830 Cannon Avenue, Cleveland. Benton will have charge of the Indiana, Illinois, and Wisconsin area and his headquarters will be at Thermoid's Chicago office.

Manager Chicago plant

Announcement is made by American Car and Foundry Company that John F. Considine has been appointed district manager of its Chicago plant. He had previously been assistant district manager of that plant.

Considine is a native of Chicago Illinois, where he attended grade and high schools. After graduation he was first employed by the Pullman Company in the engineering department. He subsequently resigned to take a position as car inspector and continued in that capacity until 1924 when he entered the employ of ACF as an inspector at the Wood Mill. Thereafter he served as assistant foreman in various departments until he was promoted to general foreman of the Wood Erection Shop and in 1942 was made superintendent of the Wood Car Department; later to general superintendent, until finally he was assigned to the district manager's office.

Firm name changed

At their annual meeting stockholders of National Oil Products Company, voted to change the company's name to Nopco Chemical Company in order to identify the company more readily with the chemical industry.

Nopco has made a favorable beginning on 1947, Charles P. Gulick, president, and director of the board of directors, told stockholders at the meeting. Sales and earnings for the two months ended February 28 were substantially ahead of those for the corresponding months of 1946.

Opens new branch

Floyd C. Myers, regional manager of Black, Sivalls and Bryson, Inc., announces the opening of a new company sales and service branch at Lubbock, Texas. The branch will specialize in oilfield equipment, and will also act as an outlet for BS&B special products.

Clint G. Ross, who for the last several years has managed the Artesia, New Mexico, branch, will direct the new operations.

France Metal Packing Rings distinguished by the tangent cut, step joint design, have set the standard for the industry.

STOP LEAKS AND PREVENT SHUTDOWNS

Records of thousands of new and renewal installations bear out the fact that it pays to install or replace with France Metal Packing. It pays off in lowered maintenance cost and trouble-free operation of pumps, engines and compressors.

Leading engine builders and operating engineers find France Packing more economical and satisfactory under every condition of service. It lasts longer, causes less wear, consumes less power, and eliminates leakage.

Whatever your packing requirements, you can look to France with complete assurance. You should know about these and other advantages of France Metal Packing.

Write today for our latest brochure, "Industrial Packing"—sent free for your asking.

FRANCE PACKING COMPANY
PHILADELPHIA 35, PA.

REPRESENTATIVES IN PRINCIPAL CITIES

Record attendance at Houston Nomads

International guests at Houston Nomads meeting, left to right: Front row—R. T. Finley, United British Oilfields of Trinidad, Point Fortin, Trinidad; D. C. Scott, Shell Company, Bogota, Colombia; R. L. Holden, Texas Petroleum Company, Barranquila, Colombia; Delbert Lewis, Calgary, Alberta, Canada; D. U. Skinner, Homco, Caracas, Venezuela. Back row—T. B. Herndon, National Supply Company, Caracas, Venezuela; N. E. Giles, Socony-Vacuum Oil Company, Caracas, Venezuela; C. B. Miller, Mene Grande Oil Company, Barcelona, Venezuela; "Sonny" Calvert, export representative, London, England.

A record attendance, including nine international visitors, registered at the April meeting of the Houston Chapter of Nomads. Given recognition by the group was Charles W. Thornhill, Houston, of Thornhill-Craver Company, recently named president for 1947 of the National Board of Regents of Nomads. A talk on the FBI by Galen N. Willis, agent in charge of the Houston office, and a colored movie of the Orange Bowl football games featured the evening.

Heads Pan American

Election of Bruce K. Brown as president of the Pan American Petroleum Corporation has been announced by directors of the company. The former president, Dr. Robert E. Wilson, steps up to the board chairmanship of Pan-Am, wholly owned direct subsidiary of Standard Oil (Indiana), of which he is chairman of the board of directors.

Brown will continue as a vice president and director of the parent company.

Coincident with Brown's election, Dr. Wilson announced that Joseph K. Roberts, general manager of research, who has been under Brown's general direction, would henceforth, as an independent department head, report directly to the chairman.

New research division

Emphasizing a program to augment the development and recovery of oil reserves, California Research Corporation, Standard of California subsidiary, has announced the formation of a new division to coordinate and expand the company's oil-field research activities.

Heading the division will be E. G. Gaylord, who has been elected vice president and director of the research company.

Activities of the new branch will embrace laboratory and research services for the various oil-field operations of Standard, its subsidiaries and affiliates, including geological, geophysical, drilling, producing, and surface processing work. Laboratories for this work will be at La Habra, California, where a new structure is now under construction.

CNGA June frolic

Entertainment Committee Chairman Phil W. Mettling met with members of his committee, R. E. Raasch, Tom Webb, Ed Bishop, and Marion Arnold recently to work out plans for the coming California Natural Gasoline Association June Frolic.

A top notch show will be produced by Walter Trask, featuring the latest M. C. sensation from Broadway, Lionel Kay, formerly three years with Olson and Johnson's "Sons of Fun." Two hours of outstanding entertainment will follow the barbecue dinner.

An old fashioned Olio is being planned to allow those who like to sing to display their voices.

AMERICAN ROLLER BEARINGS

When we say *super service*, we mean just that! Because AMERICAN SUPER HEAVY DUTY ROLLER BEARINGS are *specially built* for applications requiring *super* strength . . . *super* performance . . . *super* endurance. They are not just "stock" bearings. Often they are designed to exact specifications for the job they are required to do. Their vital, extra capacity to render continuous 24-hour-a-day performance in the heaviest equipment built, under the most adverse service conditions to be encountered in modern industry, is the reason why, for more than 25 years, AMERICANS have been first choice with manufacturers and designers of heavy industrial and oil country machinery. Once adopted, no manufacturer has ever had to switch from AMERICANS. Write today for complete technical details.

AMERICAN ROLLER BEARING COMPANY
PITTSBURGH PENNSYLVANIA
Pacific Coast Office: 1718 S. Elower St., Los Angeles, Calif.

AMERICAN
Heavy-Duty ROLLER BEARINGS

Richard P. McKey joins Petroleum Engineer staff

Richard P. McKey, who has been in the trade journal publication field for 18 years, has joined the staff of *The Petroleum Engineer* as Pacific Coast advertising manager. His present address is 742 South Wilton Place, Los Angeles 5, California. The telephone number is FItzroy 2726.

McKey attended Stanford University and worked on several Los Angeles newspapers before becoming assistant advertising manager of the *Petroleum World* in 1929. Later he became business manager of this publication.

In 1942 he entered the Army Air Corps as an engineering officer and was stationed at Duncan Field, San Antonio, Texas, and Williams Field, Arizona. He spent two years at Agra, India. When discharged from the air corps he held the rank of major and is now a member of the reserve.

Since leaving the Army Air Corps in July, 1946, McKey has been California representative with J. Howard Tinkham of *The Oil and Gas Journal*.

Allan Edwards, Inc.

Allan J. "Scotty" Edwards, co-partner in the firm of M. P. Hampton and Company, dealers in pipe-line and oil-field equipment and supplies, has purchased the partnership to create Allan Edwards, Inc.

Allan J. Edwards

The new corporation will continue to handle the same line of pipe-line and oil-field equipment and supplies as formerly, retaining the same offices in the McBirney Building in Tulsa.

A. J. "Scotty" Edwards is widely known in oil circles, having been actively engaged in the oil field supply business for the last 25 years. For some 20 years he was associated with Black, Sivalls, and Bryson. Most of the time he was with that firm he was general sales manager.

Roebling appointment

E. C. Low, vice president in charge of sales of John A. Roebling's Sons Company, Trenton, New Jersey, announces the appointment of A. R. Robinson as manager of the company's Seattle branch.

Robinson joined the Roebling company in 1936 as a salesman in the Portland branch.

Export distributor

United States Rubber Export Company, Ltd. has been appointed as executive export distributors for Prufcoat protective coatings and Pruftite transparent waterproofing, manufactured by Prufcoat Laboratories, Inc.

WECO
The Original
WING
UNION
Covers the Field!
WECO Fig. 100
1000 lb. Test
Yellow and Black
"Screw Thread"
WECO Fig. 200
2000 lb. Test
Gray and Blue
"Sampson Thread"
WECO Fig. 400
4000 lb. Test
Red and Black
"Speed Thread"
WECO Fig. 600
6000 lb. Test
Silver and Black
"Dizzy Thread"
Make your choice of Wing Unions from a line-up of proved winners. WECO . . . home of the original wing unions . . . offers the most advanced and complete line of wing unions in the world for a variety of specific services. You can select your tailor-made WECO Unions by size and pressure to fit any service. You can bank on the extra strength of WECO's Original design for dependability. WECO Wing Unions are made in sizes 1" to 10" and 1000 to 12,000 lb. test pressure. WECO 6000 lb. Dizzy Thread Wing Unions are made in 1" size for blowout preventer hook-ups. Specify WECO Wing Unions. They truly cover the field!
WELL EQUIPMENT MFG. CORP.
Subsidiary of Chiksan Company
Houston 1, Texas
Export Representation
CHIKSAN EXPORT COMPANY
New York 7
Brea, Calif
Houston 1
WECO
Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

J & L personnel changes

The following changes in personnel, effective April 29, are announced by Jones and Laughlin Steel Corporation:

W. J. Creighton retires from the office of executive vice president, but continues in an active advisory capacity as consultant to the chairman of the board of directors. He also continues to be a director and a member of the executive committee.

Frank R. Denton, a newly elected director, has also been elected a member of the executive committee.

C. L. Austin, heretofore a director and the treasurer, was elected to the additional offices of member of the executive committee and vice president.

H. Parker Sharp, heretofore a director and the general counsel, was elected to the additional offices of member of the executive committee and vice president.

V. H. Lawrence, heretofore general superintendent of the Otis Works, was elected a vice president. W. R. Elliot, formerly assistant general superintendent of the Otis Works, has succeeded V. H. Lawrence as general superintendent of that Works.

W. H. Dupka, heretofore the controller, was elected to the additional office of vice president.

H. W. Graham, heretofore director of technology, was elected to the additional office of vice president.

HAERING
ORGANIC GLUCOSATES
control SCALE, CORROSION & ALGAE
in the PETROLEUM INDUSTRY
WRITE ON YOUR LETTERHEAD FOR SPECIAL LITERATURE
WE READ WATER
D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Illinois

W. Randall Compton has been appointed assistant to the president, effective June 2.

W. C. Plummer, an attorney of the corporation, was appointed to the additional office of assistant secretary.

Suter joins Totco

Oswald Suter, for the last 11 years a member of the Waltham Watch Company and for the last five years its chief engineer, has joined the staff of the Technical Oil Tool Corporation, Ltd., as chief engineer in charge of manufacturing and development. This appointment, according to J. B. Wood, president of Totco, brings to the oil industry the services of one of the country's foremost horological engineers.

Oswald Suter

Suter received his horological training in Switzerland, graduating in 1923 from the St. Imier Institute of Technology. Since coming to the United States in 1927, he has been with both the Bulova Watch Company and the Waltham Watch Company.

Elected vice president

Rudolph E. Reimer, secretary and treasurer of Dresser Industries, Inc., Cleveland, Ohio, was also elected a vice president of the company at a meeting of the board of directors in New York, April 22.

A native of Cincinnati, Reimer attended public schools there and graduated from the University of Cincinnati in 1928 with the degree of commercial engineer. He has been associated with Dresser interests since 1929, when he became controller of Dresser Manufacturing Company, Bradford, Pennsylvania, now an operating division of Dresser Industries, Inc. He became treasurer of that organization in 1932 and in 1943 was elected secretary and treasurer of Dresser Industries, Inc.

Add a director

At the annual meeting in New York of General American Transportation Corporation stockholders, the present board of directors was reelected. Following the stockholders' meeting, the board of directors held its annual meeting, at which the number of directors was increased from 11 to 12 members.

Walter W. Fowler, vice president in charge of the corporation's export activities, was unanimously elected to the post of director.

Nelly to new post

H. M. Nelly, Jr., formerly with J. F. Pritchard and Company, is now vice president of Refinery Maintenance Company, Compton, California. Nelly's headquarters are in Houston, Texas.

Coast representative

Petro-Chem Development Company, Inc., has announced the appointment of M. A. Grizzle as its Pacific Coast sales representative. Grizzle has been connected with the sale of Petro-Chem furnaces and heaters in this territory since 1942. First, for the account of Bethlehem Supply Company, who still hold the Petro-Chem Development Company sales representation in the Mid-Continent, Gulf Coast, and Rocky Mountain territories. More recently he was associated with the Petroleum Equipment Company now Bethlehem Supply Company of California who, during that time, were sales representatives for Petro-Chem Development Company on the Pacific Coast.

M. A. Grizzle

Grizzle has his offices in the Petroleum Building, 714 West Olympic Boulevard, Los Angeles, California.

New laboratory building

Plans for the construction of a new laboratory building at El Segundo for California Research Corporation, Standard of California subsidiary, has been announced.

The structure, a one-story building with dimensions of 54 ft by 160 ft, will centralize all southern California technical research and development work on petroleum products and refining processes at Standard's El Segundo refinery.

Contract for the job has been awarded to P. J. Walker Company. Preliminary work is already under way. Completion of the job is expected early in 1948.

West Coast manager

Ladish Company, of Cudahy, Wisconsin, announces the appointment of H. L. Pehrson as manager of West Coast sales of Ladish controlled quality forged and seamless welding pipe fittings with offices at 714 West Olympic Boulevard, Los Angeles 15, California.

Pehrson, already well known in western piping circles, has been closely associated with the valve and piping business for the last 16 years with the Reading Pratt and Cady Division of American Chain and Cable Company. The last six years of this association were spent as Southern California representative on petroleum and industrial sales.

Manager at Carthage

F. S. Vernon has been appointed manager at Carthage, Texas, by the Continental Supply Company succeeding F. N. Metcalf who has been made foreign representative. Vernon formerly was a field salesman at Shreveport. Also announced is the naming of James E. Keffer, formerly floorman at McCamey, Texas, as store manager at that point. He succeeds R. K. Thompson, resigned.

Service over the years with FORGED STEEL UNIONS

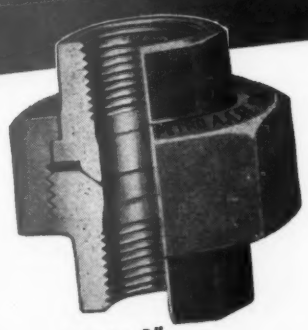
Unions are hot forged from solid round bars of high quality Open Hearth Forging Steel.

Handle-Bar

Hi-Speed Handle-Bar Unions with integral steel to steel seats, or completely fused bronze to bronze seats, black or Udylite (cadmium plated) — sizes from ⅜" to 4" inclusive in 4000 test, sizes 2" to 4" inclusive in 6000 test.

4000 Test Unions furnished with Briggs Standard steam threads in pipe ends, whereas the 6000 Test Union has long pipe ends with API line pipe threads. Nut threads are modified Acme to facilitate easy and speedy assembly and disassembly. Seat design is a 45 degree cone, machined and cold rolled, to a ball seat on male end. Handle-Bar Unions are recommended for all services where they are made up and taken down frequently.

Petro



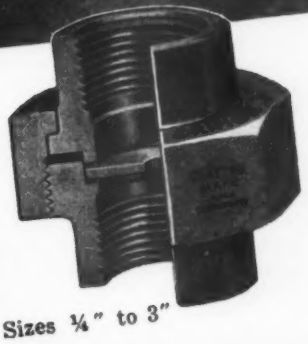
Sizes ⅛" to 3"

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S. W. P.-2000 lbs. C. W. P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is used.

Orifice

Ideal for flow control of Steam, Oil, Ammonia, Water, Gas or Air. Also for metering and measuring. 600 lbs. S. W. P. or 2000 lbs. C. W. P. The ORIFICE plate is furnished in cold rolled 18-8 stainless steel. ORIFICE plate and gaskets are set in a groove of solid steel to safeguard against blowing of gaskets and resultant trouble. The ORIFICE union has extra heavy ends and nut with the nut threads permanently lubricated.



Sizes ¼" to 3"

ORDER BY TRADE NAME FROM YOUR LOCAL SUPPLY STORE

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS SINCE 1912

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

L. A. Nomads meeting

The regular monthly meeting of Los Angeles Nomads was held April 16 at the Jonathan Club, with Bob Eiche presiding, and a nice turnout of members, local friends, and foreign guests to participate in and enjoy another excellent program, arranged by that prince of arrangers, Lee Laird, the Chiksan exec. After the usual hour of socializing, President Bob called the meeting to order, and at his request, Johnny Mason singled out and introduced the following foreign guests: Henri C. Piek, Standard Vacuum Oil Company; Paul Molidor, Tropical Oil Company, Colombia; Thomas D. Foster, Standard Vacuum Oil Company; T. C. Oakes, Iraq Petroleum Company; Bill Haney, Socony Vacuum, Colombia, and M. W. Zaikowsky, The Texas Company, Venezuela.

Elmer Decker inducted several new members, impressing on them fully the fact that wherever oil is produced, and especially in foreign fields, Nomads are looked upon, not only as members of a highly reputable organization, but as representatives of a great industry. It is, therefore, incumbent on the traveling member to comfort himself, if not with dignity, at least with a fitting realization of his responsibility. The inductees were: John McEwen, William S. Althouse, Jr., and Robert Traill Harcus. Berale R. Thompson and M. J. Archer were also due to be inducted as new members, but were unable to be present. It was announced that P. Taylor Bannerman had been elected to regular membership.

The speakers of the evening, J. L. Ray, assistant chief engineer, and A. J. Phelan, chief engineer, Northrup Hendy Company, Hawthorne, California, were presented by Fred Ripley, Jr. The topic of their address was "gas turbines," and it was illustrated by a series of slide projections, designed to show the method of operation, and to demonstrate by means of cross sectional drawings, the more recent developments in gas turbine design.

Use Acme Cable Tools

Trustworthy Since 1900

Acme Drilling Jars need no boasting generalities to impress you with their performance records. Their yearly, unmatched low percentage of field-failures tells the story: less than 1.5% . . . Surely, 98.5% of perfect is a high "batting average"!

The "whys" are also known facts: Our Jar steel specifications are so rigid — allowing less than a 5-point range — that the mills charge extra. They know we never compromise on quality . . . Our constant analyses see to that!

Like vigilance prevails throughout our plant: In engineering, forging, machining, etc. Every forging must be RIGHT . . . Its uniformity is electrically controlled; automatically shutting off at a point for proven CORRECT forging . . . No "burning" possible.

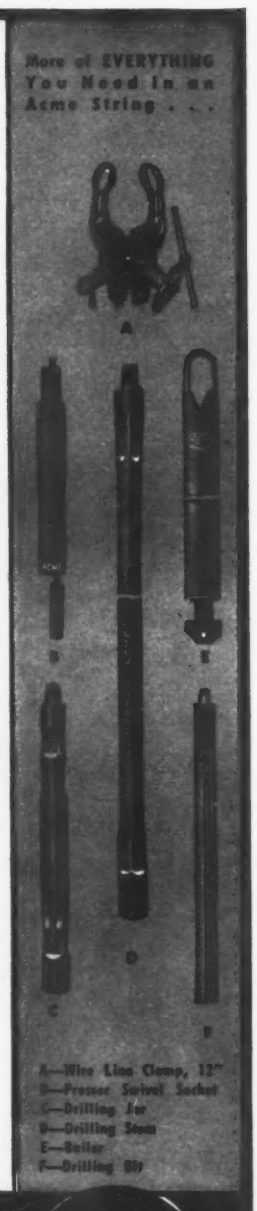
Our Jar makers are of the "Old School" — they slight no detail toward construction perfection. Their rule is: "Take time to do the job right" . . . A policy which Acme's 47-years of "know-how" proves pays off — in trustworthy tools that save grief everywhere used.

Featured here is Rein Type Welded Jar (Fig. 107). See color panel for other Acme Drilling Tools — for your more profitable use.

* * *

For more information, see our 24-page Catalog in Composite Catalog (Vol. 1). Or tell us your needs, by TODAY'S mail.

Fig. 107
Acme Rein Type
Drilling Jar



Acme Fishing Tool Co.

PARKERSBURG, W. VA.

Export Office: 19 Rector St., New York 6, N. Y.

Since 1900

Made chief engineer

J. C. Axelson, president and general manager of Axelson Manufacturing Company, Los Angeles, California, announces the appointment of Glynn Williams as chief engineer to succeed E. W. Ostrom whose resignation was effective April 15.

Glynn Williams

Williams has been with the Axelson organization since 1934 serving in various capacities in the engineering department, recently being divisional head of aircraft engineering.

Ostrom has served 26 years with the company beginning in 1920 and was promoted to chief engineer in 1934.

Jarecki changes

W. Howard Pape, vice president in charge of Jarecki Manufacturing Company's supply division, announces the following personnel changes:

N. D. Marko has been promoted to the position of district manager of the Panhandle area with district offices at Borger, Texas. He was formerly manager at the Borger store where he will be replaced by Fred Niemeier who has been field salesman.

J. D. Freeman, formerly manager of the Russell, Kansas, store, has been promoted to district manager with district headquarters at Great Bend, Kansas. After his World War II service as chief of contract planning for a leading aircraft manufacturer, he joined Jarecki in district sales promotion work. J. W. Stewart has been promoted from field salesman to store manager at Russell.

Hugh A. Brightwell and Jack Barnes have been added to the sales staff at Tulsa. Brightwell has rejoined the company after several years' absence and Barnes after more than three years with the armed forces in the Pacific Theater.

Offices moved

The Catalytic Construction Company has announced the removal of its offices to 1528 Walnut Street, Philadelphia 2. Pennsylvania.

Continental appointments

The Continental Supply Company, Dallas, Texas, has announced the appointment of two additions to the organization's supervisory personnel.

B. L. Hindman has been named assistant district manager in charge of operations at Laurel, Brookhaven, Natchez,

R. Hortenstine, Jr.

B. L. Hindman

and Jackson, Mississippi, and Jena, Louisiana. His headquarters are at Brookhaven.

Hindman joined Continental in 1930, immediately following his graduation from Texas A. && M. College. He has been stationed in West and East Texas, engaged in machinery sales.

Raleigh Hortenstine, Jr., is now assistant district manager for the area made up of Baton Rouge, New Orleans, Houma, New Iberia, Eunice, and Lake Charles, Louisiana, with headquarters at New Iberia.

Hortenstine has been with Continental continuously since entering the company's employ in 1935, upon graduation from Texas University. He has served in various capacities in Dallas and in the field during that time.

Kellex officials

The Kellex Corporation, subsidiary of The M. W. Kellogg Company, petroleum engineers, of New York, has announced that M. W. Kellogg, founder and chairman of the board of the parent company, had been elected to the newly created post of chairman of the board of the Kellex Corporation. Kellogg has been succeeded in his previous post as president of Kellex by H. R. Austin, formerly executive vice president. Austin will hold his Kellex post concurrently with his position as president of The Kellogg Company.

Creation of the new Kellex post of board chairman, it was stated, was made necessary by the rapidly expanding activities of that company in the fields of atomic power and guided missiles.

Purchase firm

The General American Transportation Corporation of Chicago has acquired The L. R. Christie Company of New York City, for more than 40 years well-known builders of industrial dryers, calcinators, and coolers, according to an announcement just released.

The Christie line will complement General America's wide variety of drying, dewatering, and cooling machinery.

IT'S THE FOOTAGE OF HOLE IN THE OIL SAND THAT COUNTS

This Dutchman's Great-Great Grandfather Solved a Drainage Problem

DRAIN YOUR OIL SANDS... *like Dutch!*

Horizontal drain holes greatly increase the total drainage area of an oil well. They also provide unimpeded passages for the oil to travel from all directions into the central bore. Slow and uniform drainage, insured by horizontal holes, greatly reduces tendency of the gas to by-pass the oil. The spacious drainage channels also act as underground collecting chambers in which the gas in solution is separated from the oil under decreased pressure and velocity and to a large extent re-enters the formation. This preservation of the formation pressure will enable the well to produce at a much higher rate without exceeding the limits of efficient production.

Request new Engineering Bulletin

TURBINE BIT COMPANY

(Under the ownership of John A. Zublin)

2369 E. 51st St. (Phones: JE. 4433, JE. 6151) Los Angeles 11, Calif.

Zublin

HORIZONTAL WELL DRILLING

Complete new buildings

The post-war expansion and reorganization program of Stewart and Stevenson Services was climaxed recently by the completion of new larger general offices, larger parts and service department, re-manufacturing plant, and show rooms for General Motors diesel engines, electrical switch gear, and Continental Red Seal engines at 4516 Harrisburg Boulevard, Houston, Texas, it was announced by Joe Manning, manager. The new facilities of the company also include sales conference rooms and a larger, modern engineering department.

For the convenience of engine buyers, a spacious show room has been added fronting on Harrisburg Boulevard, in which are displayed diesel and gas engines, power units and oil-field utility units, marine engines, and similar equipment. Adjoining the show rooms are air-conditioned sales conference rooms.

Conveniently located behind the offices is the parts and service department, which covers more than 10,000 sq ft of floor area and in which are stocked sufficient parts to completely rebuild any G. M. diesel engine sold by Stewart and Stevenson.

In the new fireproof building that houses the offices, display show rooms and parts department, is also located the engine remanufacturing division.

The company maintains a complete fabrication and welding department as well as a modern machine shop for fabricating and assembling oil-field utility units, auxiliary generator sets, and portable pumping units.

A larger and better equipped electrical department has been installed, which provides repair facilities for all types of electric starters, generators, and controls.

Motorola building

Paul K. Povlson, vice president in charge of operations for Motorola, has announced that work on a one-story production building will begin this month. The structure will contain 22,000 sq ft of space and is designed for production of the Motorola Television Receiver.

Situated on property now owned by the Galvin Manufacturing Corporation, the building will be to the rear of present Motorola engineering building.

Ragnar Benson Inc. of Chicago have been awarded the contract for the work.

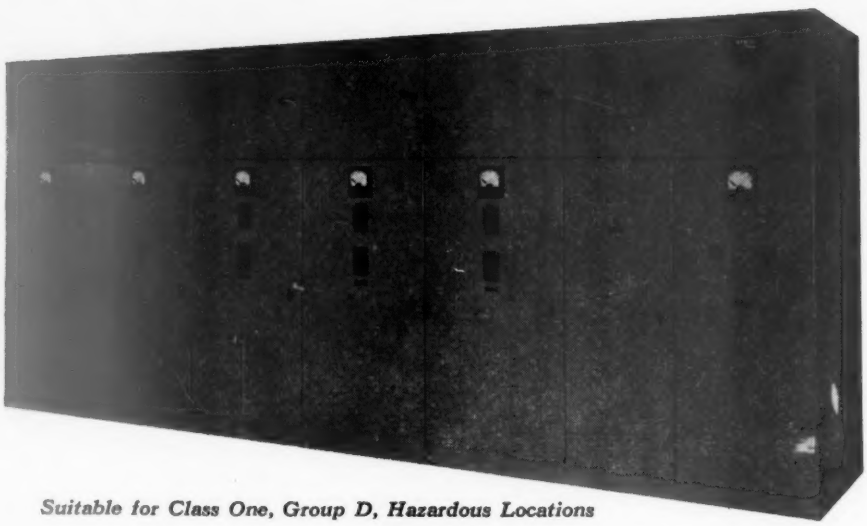
New sales assignments

As part of an expanded sales and service program at Well Equipment Manufacturing Corporation, Houston, Texas, S. W. Lomax and H. A. (Al) Ferguson have been given new sales assignments.

Lomax, recently added to the Weco sales staff, will work out of Houston and cover the Gulf Coast area.

Ferguson opened a new sales and service territory for Weco and has moved to Gulf Port, Mississippi. He will cover eastern Louisiana, southern Mississippi, Alabama, and Florida.

Explosion-Proof
High Voltage Motor Control



Suitable for Class One, Group D, Hazardous Locations

Utilizes—

- Current limiting fuses.
- Heavy duty Starting Contactor, oil immersed.
- Unit construction.

Provides the following motor protection:

- Thermal overload.
- Current balance, single phase.
- Instantaneous undervoltage protection.

OUR Engineers are specialists with long experience in the design of Electrical Equipment for the Petroleum Industry and are available for consultation with your engineers in planning equipment to meet the most exacting requirements of Refineries for both Standard and Custom-Built Electrical Equipment.

NELSON ELECTRIC MANUFACTURING CO.

217 North Detroit — TULSA, OKLAHOMA — Telephone 2-5131

MANUFACTURERS OF:

Explosion Proof Motor Controls
Junction Boxes and Enclosures
Circuit Breakers and Lighting Panels
Oil Field Motor Controls
Automatic Pipe Line Sampling Devices
Cathodic Protection Equipment
Switchboards
Instrument and Control Panels
Unit Substations

New firm formed

W. C. Weyerman, for many years associated with the oil industry, has formed the Wyco Equipment and Engineering Company, 3920 Fannin Street, Houston, Texas. The new firm began operating April 1 and is representing several manufacturers of equipment for the oil industry.

W. C. Weyerman

Weyerman is a graduate chemical engineer from the University of Texas. He was with Phillips Petroleum Company for two years, having as his duties the operation, design, and construction of gasoline plants. He next became associated with the Joseph A. Coy Company as heat exchange engineer, later joining the Engineering and Construction Division of Jones and Laughlin Supply Company, where he was in charge of instrumentation design of aviation gasoline plants and refineries. During the war he served in the Navy as an engineering officer for two years. Since his discharge from the service he has been connected with the Charles Wheatley Company in the capacity of sales manager of the pump department.

To open warehouse

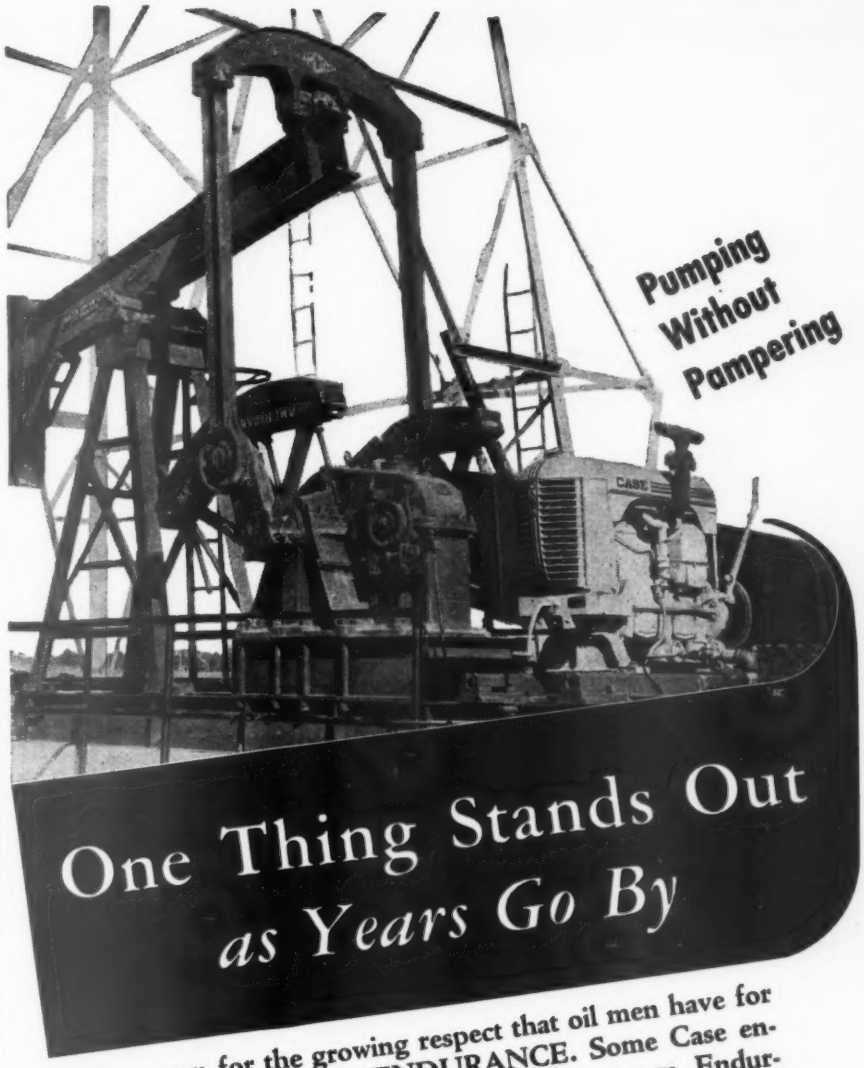
To supply the need for increased expanded service facilities Thermoid Company has acquired a new warehouse in Wabash, Indiana, which was opened April 15. With the opening of this new unit, all business formerly handled by the key warehouse in Chicago was transferred and that operation closed.

The new warehouse is operated by a staff of 18, under the direction of H. L. Conover, who went to Wabash from the main office in Trenton. Shipping from the new warehouse is largely by truck, and permits door-to-door shipments to the larger cities, an advantage which was not possible from the congested Chicago location.

To enlarge plant

To meet the present extraordinary demand for cement, the Lone Star Cement Corporation has completed plans for enlarging the productive capacity of its New Orleans plant. The additional facilities consist of a 385-ft kiln, with a capacity of 2000 bbl a day, together with the installation of a large combination mill for raw grinding and a new finish grinding unit, to bring the total capacity of the plant up to 6000 bbl daily.

This program involves an expenditure in excess of $1,000,000 and contracts are being placed for the delivery and installation of the necessary equipment. Work will be pushed with the utmost speed and every effort is being made to have this additional plant capacity available by the end of this year, it is stated.



One Thing Stands Out
as Years Go By

Main reason for the growing respect that oil men have for Case Oilfield Engines is ENDURANCE. Some Case engines have run non-stop for as much as two years. Endurance is why they regularly run months longer before major overhaul, why forced shut-downs are rare, why minor upkeep is really minor.

One secret of this endurance is the exceptional protection provided against destructive dust and dirt. Another is the lubricating system that works "for sure" in wide extremes of weather. Altogether, it comes from making every part a bit better than might seem necessary.

Shown above on a job in the East Texas Oilfield is the 42 H.P. Model "DE." Other Case Oilfield engines are the 28½ H.P. "SE" and the 61 H.P. "LAE." For full information, call the distributor who maintains service in your area. J. I. Case Co., Racine, Wis.

OIL-FIELD ENGINES

CASE

DISTRIBUTORS

Southwest Machinery Company
1900 Linwood Blvd., Oklahoma City;
Tulsa and Hobart, Oklahoma

Wm. K. Holt Machinery Company
San Antonio, Texas

Southwest Equipment Company
Dallas and Kilgore, Texas

Goodman Bros., Inc.
Midland, Texas

Complete new buildings

The post-war expansion and reorganization program of Stewart and Stevenson Services was climaxed recently by the completion of new larger general offices, larger parts and service department, re-manufacturing plant, and show rooms for General Motors diesel engines, electrical switch gear, and Continental Red Seal engines at 4516 Harrisburg Boulevard, Houston, Texas, it was announced by Joe Manning, manager. The new facilities of the company also include sales conference rooms and a larger, modern engineering department.

For the convenience of engine buyers, a spacious show room has been added

fronting on Harrisburg Boulevard, in which are displayed diesel and gas engines, power units and oil-field utility units, marine engines, and similar equipment. Adjoining the show rooms are air-conditioned sales conference rooms.

Conveniently located behind the offices is the parts and service department, which covers more than 10,000 sq ft of floor area and in which are stocked sufficient parts to completely rebuild any G. M. diesel engine sold by Stewart and Stevenson.

In the new fireproof building that houses the offices, display show rooms and parts department, is also located the engine remanufacturing division.

The company maintains a complete fabrication and welding department as well as a modern machine shop for fabricating and assembling oil-field utility units, auxiliary generator sets, and portable pumping units.

A larger and better equipped electrical department has been installed, which provides repair facilities for all types of electric starters, generators, and controls.

Motorola building

Paul K. Povlson, vice president in charge of operations for Motorola, has announced that work on a one-story production building will begin this month. The structure will contain 22,000 sq ft of space and is designed for production of the Motorola Television Receiver.

Situated on property now owned by the Galvin Manufacturing Corporation, the building will be to the rear of present Motorola engineering building.

Ragnar Benson Inc. of Chicago have been awarded the contract for the work.

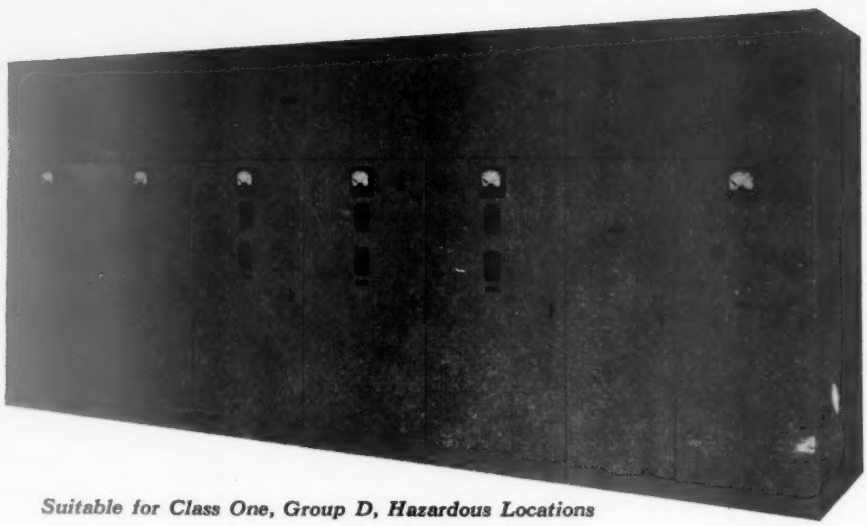
New sales assignments

As part of an expanded sales and service program at Well Equipment Manufacturing Corporation, Houston, Texas, S. W. Lomax and H. A. (Al) Ferguson have been given new sales assignments.

Lomax, recently added to the Weco sales staff, will work out of Houston and cover the Gulf Coast area.

Ferguson opened a new sales and service territory for Weco and has moved to Gulf Port, Mississippi. He will cover eastern Louisiana, southern Mississippi, Alabama, and Florida.

Explosion-Proof
High Voltage Motor Control



Suitable for Class One, Group D, Hazardous Locations

Utilizes—

- Current limiting fuses.
- Heavy duty Starting Contactor, oil immersed.
- Unit construction.

Provides the following motor protection:

- Thermal overload.
- Current balance, single phase.
- Instantaneous undervoltage protection.

OUR Engineers are specialists with long experience in the design of Electrical Equipment for the Petroleum Industry and are available for consultation with your engineers in planning equipment to meet the most exacting requirements of Refineries for both Standard and Custom-Built Electrical Equipment.

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Explosion Proof Motor Controls
Junction Boxes and Enclosures
Circuit Breakers and Lighting Panels
Oil Field Motor Controls
Automatic Pipe Line Sampling Devices
Cathodic Protection Equipment
Switchboards
Instrument and Control Panels
Unit Substations

New firm formed

W. C. Weyerman, for many years associated with the oil industry, has formed the Wyco Equipment and Engineering Company, 3920 Fannin Street, Houston, Texas. The new firm began operating April 1 and is representing several manufacturers of equipment for the oil industry.

W. C. Weyerman

Weyerman is a graduate chemical engineer from the University of Texas. He was with Phillips Petroleum Company for two years, having as his duties the operation, design, and construction of gasoline plants. He next became associated with the Joseph A. Coy Company as heat exchange engineer, later joining the Engineering and Construction Division of Jones and Laughlin Supply Company, where he was in charge of instrumentation design of aviation gasoline plants and refineries. During the war he served in the Navy as an engineering officer for two years. Since his discharge from the service he has been connected with the Charles Wheatley Company in the capacity of sales manager of the pump department.

To open warehouse

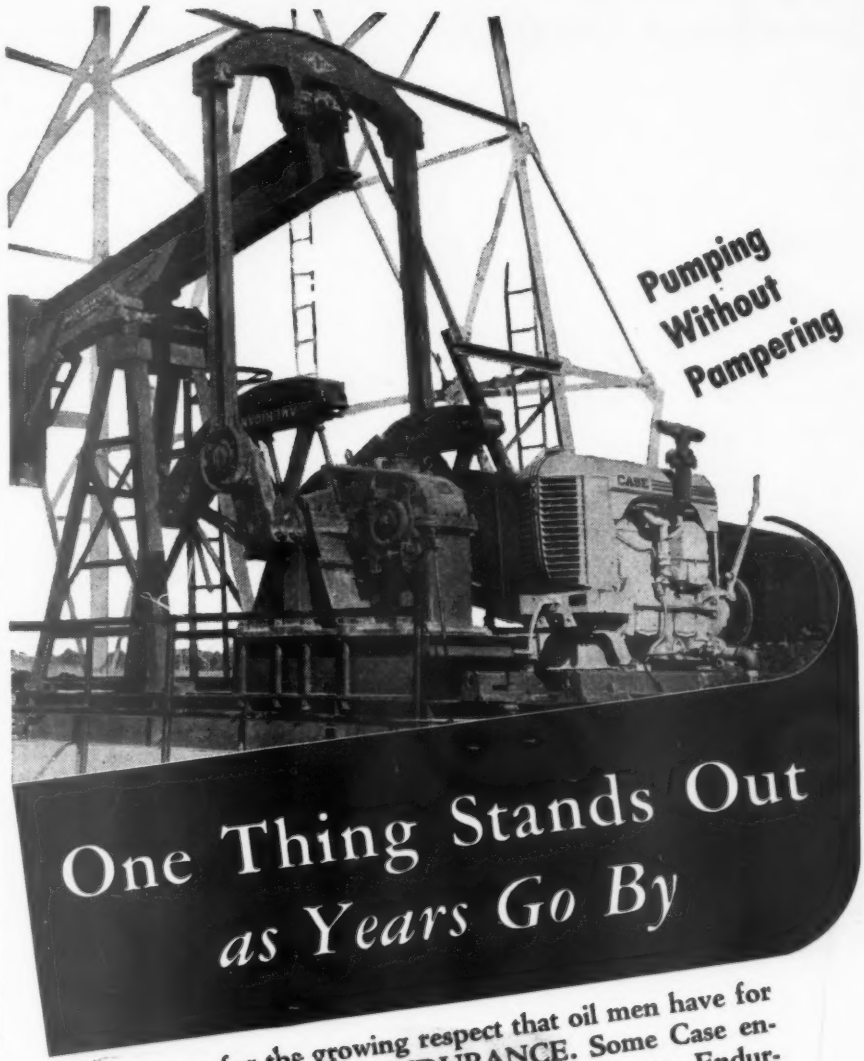
To supply the need for increased expanded service facilities Thermoid Company has acquired a new warehouse in Wabash, Indiana, which was opened April 15. With the opening of this new unit, all business formerly handled by the key warehouse in Chicago was transferred and that operation closed.

The new warehouse is operated by a staff of 18, under the direction of H. L. Conover, who went to Wabash from the main office in Trenton. Shipping from the new warehouse is largely by truck, and permits door-to-door shipments to the larger cities, an advantage which was not possible from the congested Chicago location.

To enlarge plant

To meet the present extraordinary demand for cement, the Lone Star Cement Corporation has completed plans for enlarging the productive capacity of its New Orleans plant. The additional facilities consist of a 385-ft kiln, with a capacity of 2000 bbl a day, together with the installation of a large combination mill for raw grinding and a new finish grinding unit, to bring the total capacity of the plant up to 6000 bbl daily.

This program involves an expenditure in excess of $1,000,000 and contracts are being placed for the delivery and installation of the necessary equipment. Work will be pushed with the utmost speed and every effort is being made to have this additional plant capacity available by the end of this year, it is stated.



One Thing Stands Out
as Years Go By

Main reason for the growing respect that oil men have for Case Oilfield Engines is ENDURANCE. Some Case engines have run non-stop for as much as two years. Endurance is why they regularly run months longer before major overhaul, why forced shut-downs are rare, why minor upkeep is really minor.

One secret of this endurance is the exceptional protection provided against destructive dust and dirt. Another is the lubricating system that works "for sure" in wide extremes of weather. Altogether, it comes from making every part a bit better than might seem necessary.

Shown above on a job in the East Texas Oilfield is the 42 H.P. Model "DE." Other Case Oilfield engines are the 28½ H.P. "SE" and the 61 H.P. "LAE." For full information, call the distributor who maintains service in your area. J. I. Case Co., Racine, Wis.

OIL-FIELD ENGINES.
CASE

DISTRIBUTORS

Southwest Machinery Company
1900 Linwood Blvd., Oklahoma City; Tulsa and Hobart, Oklahoma

Wm. K. Holt Machinery Company
San Antonio, Texas

Southwest Equipment Company
Dallas and Kilgore, Texas

Goodman Bros., Inc.
Midland, Texas

Allis-Chalmers set-up

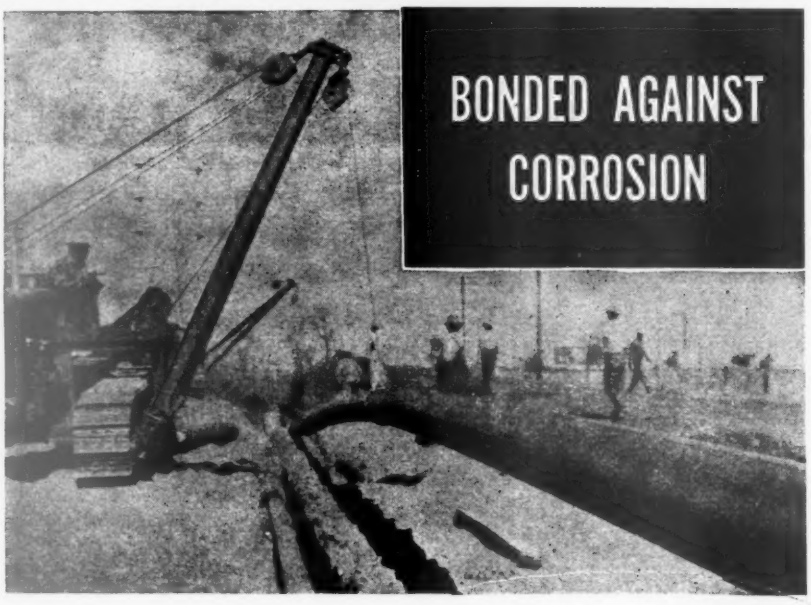
Under a newly adopted regional set-up for the field organization of the Allis-Chalmers general machinery division, Allis-Chalmers branch offices in the new regions become district offices. According to J. L. Singleton, manager of district offices, the following are now designated as district managers in the first four regions established:

In the New England region, A. B. Frost and R. H. Porterfield are managers of the New Haven and Providence district offices, respectively, reporting directly to W. F. Taylor, Boston, manager of the region.

In the Southwest region, W. R. Horrigan, Aubrey Phillips, E. R. Hury, L. G. Park, and R. I. Moore are managers of the Amarillo, Houston, San Antonio, Shreveport, and Tulsa district offices, respectively, reporting directly to J. L. Pratt, region manager, who has been succeeded as manager of the Dallas district office by H. L. Reynolds.

In the Southeast region, J. J. Greagan, William Parker, J. W. Roberts, G. H. Hoffman, A. R. Knauss, Joseph Bronaugh, R. F. Muller, and A. D. Robertson are managers of the Birmingham, Charlotte, Chattanooga, Knoxville, Memphis, Miami, New Orleans, and Tampa district offices reporting directly to D. S. Kerr, manager of the region, who is succeeded as manager of the Atlanta district office by Charles F. O'Riordan.

In the Pacific region, F. V. Sams, F. Harvey Searight, and U. E. Sandelin remain as managers of the Portland, San Francisco, and Seattle district offices, respectively, reporting directly to A. J. Schmitz, manager of the region. In the same region, C. W. Schweers, formerly manager of the firm's Houston district office, becomes manager of the Los Angeles district office succeeding A. D. Brown, named manager of the company's Washington, D. C. office. R. N. Landreth, who has been acting manager of the Washington office, will now devote full time to his special duties as assistant to Vice President Johnson. A. R. Kohlmetz remains as manager of the Spokane branch of the Seattle district.



...with Reilly Pipe Enamel

This booklet, describing Reilly Protective Coatings for metal, concrete, brick and wood surfaces, will be sent on request.

★ The protection which any good coating gives to a pipe line is dependent upon the bond between the coating and the steel. On pipe lines coated with Reilly Enamel, the coating is so tightly bonded to the metal that it is unaffected by abrasion, soil stress, direct impact or shock. The tough Reilly coating provides dependable and lasting protection against moisture, electrolysis, extremes of temperature, soil acids and alkalies, and all other corrosive agencies.

Reilly Pipe Enamel is manufactured in two standard grades, also to meet special requirements.

REILLY TAR & CHEMICAL CORPORATION
Merchants Bank Bldg., Indianapolis 4, Ind.
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Reilly Protective Coatings

To open London office

W. O. Calvert, prominent in South America oil circles for many years, having been with Standard of Venezuela from 1925 to 1935 and subsequently employed in equipment sales work, has announced plans for opening offices in London in the near future to represent U. S. equipment manufacturers in the Near and Far East.

W. O. Calvert

Calvert will devote his entire time to the promotion of sales in that area for A-1 Bit and Tool Company, Mission Manufacturing Company, and Thornhill-Carver Company (Unibolt).

Prior to establishing a manufacturer's representative business in London, Calvert was a member of the firm of Gases Industriales de Venezuela.

Chicago offices moved

The Chicago offices of Tube Turns, Inc., of Louisville, Kentucky, have been moved to suite 904 Fairbanks-Morse Building, 600 South Michigan Avenue. The phone number, Harrison 8527, remains the same.

The new and larger offices will be the headquarters for George C. Anderson, district manager of Tube Turns' Welding Fittings Division, Donald A. MacNeil, district manager of Tube Turns' Forging Divisions, and their staffs.

San Francisco manager

L. W. Rodolf, manager of the Gardner-Denver Company branch office in El Paso, Texas, for 28 years, has been appointed manager of the San Francisco branch office, according to an announcement made recently by Gardner-Denver officials. F. R. McNamara has been appointed new manager of the El Paso office. McNamara formerly was a company representative in the Philippines.

McClure to Tulsa

J. N. McClure, who was appointed manager of the petroleum division of Elliott Company a year ago, has moved his headquarters from Houston, Texas, to Tulsa, Oklahoma. McClure will also take on the duties of manager of the Tulsa district.

J. N. McClure

A graduate of Georgia Tech, McClure joined the Elliott Company in 1923. He has served as field engineer in the Philadelphia, St. Louis, and Tulsa offices before becoming Kansas City district manager in 1941.

Production manager

Brig. Gen. Hugh C. Minton, who was awarded the Distinguished Service Medal for his "able direction" of the Army Service Forces' Production Division during World War II, will become production manager of Koppers Company, Inc., on July 1, it is announced.

In his new position, General Minton will report directly to General Brehon Somervell, president of Koppers, thereby re-establishing in civilian life a relationship set up in wartime when General Somervell was commanding general of the Army Service Forces.

In announcing the appointment of General Minton to the Koppers' position, General Somervell said:

"General Minton's splendid record of service to the nation and his long and close association with equipment manufacturers makes him thoroughly qualified for the important new post with Koppers.

"He will be responsible for the efficiency of our manufacturing operations, dissemination of information on manufacturing methods, advice and consultation on such methods, installation of new and improved systems for manufacturing processes, factory and shop management, and plant development and expansion."

Unit Rig reorganization

Unit Rig and Equipment Company, Tulsa, Oklahoma, formerly a partnership composed of J. R. Underwood, H. S. Chancey, William Guier, and R. E. Carter, was dissolved by the death of Underwood in May, 1946. In the settlement of the Underwood Estate, the company went through a friendly receivership and was subsequently sold on April 1, 1947, in District Court in Tulsa. The company was acquired by The Unit Rig and Equipment Company, Inc., a Delaware corporation, whose personnel is made up principally of former partners in the old company. The officers are, William Guier, president, R. E. Carter, vice president, and F. C. Morton, secretary-treasurer. The new corporation purchased the interests of H. S. Chancey, and of Mrs. Jennie Underwood, executrix of the Underwood Estate.

The company has been active in the manufacture and sale of drilling and well-servicing equipment for the last ten years. The plant facilities have been expanded from time to time in keeping with the demand for this equipment and more than 200 skilled workmen are employed at the present time. It is expected that the new company officials will expand it further to accommodate their new line of servicing equipment and new additions to the drilling line to be announced in the near future.

The offices of the company are on the fourth floor of the Kennedy Building, and the plant is at 324 West Archer.

Rocky Mountain agent

Fred S. Dewel, veteran oil country supply specialist, has been named Rocky Mountain agent for Larkin Packer Company, Inc., W. H. Larkin, president, has announced.

Dewel will be the exclusive representative for all Larkin products throughout the Rocky Mountain area.

Formerly associated with Shell Oil Company and Bovaird Supply Company in Kansas, Dewel has been a manufacturers agent for the last nine years. His territory included all active areas east of the Mississippi.

Dewel attended Oklahoma A & M. He is a member of the API.

"K.O." CORROSION ... in a single operation

IN ONE OPERATION, this machine delivers a double-barreled knockout to soil corrosion. It applies TWO coats of enamel ... TWO layers of J-M Asbestos Felts ... just as fast as pipelines can be assembled.

This *double* protection in a single operation means installation savings, plus long-term maintenance savings, because J-M Asbestos Pipeline Felts are made of time-defying, rotproof asbestos fibers. That's why J-M felts are the most widely used material for guarding enamel against soil stresses and distortion.

Get all the engineering facts and figures by writing Johns-Manville, Box 290, N. Y. 16, N. Y.

This machine *double coats* and *double wraps* in one operation. It was developed especially for J-M by Crutcher-Rolfs-Cummings of Houston, Texas.

Johns-Manville JM PRODUCT
ASBESTOS Pipeline Felts

P.E.S.A. convention big success

By every process of measurement, the convention of the Petroleum Equipment Suppliers' Association, held at the Mark Hopkins Hotel in San Francisco from May 4 to 7, inclusive, was a signal success. There were present representatives of equipment and supply organizations from many states, including Texas, Oklahoma, Louisiana, Ohio, West Virginia, Missouri, New York, Pennsylvania, and, of course, California, and certainly with such a substantial cross-section of the industry, there was nothing lacking in other respects to make this interlude both educational and diverting to all concerned.

The opening day, Sunday, was devoted by the delegates to settling down in their respective rooms, and registering, so that when the business sessions began on Monday, there would be nothing to interfere. Promptly at 10 a. m. Monday, Hugh H. Glen, president, started the formal sessions with a brief word of welcome to the delegates, immediately thereafter appointing a committee, headed by Rodney Durkee, to consider the delicate matter of dues, and recommend an equitable system of payment. Following this, there was launched an open forum on sales accounting procedures, in which R. M. "Dick" Morrison, general purchasing agent of The Texas Company, New York, minced no words in expressing his belief that the equipment and supply business was pretty thoroughly bogged down with paper work in its sales accounting. Although his accusations were propounded somewhat good naturedly, they were obviously meant to be taken seriously—and they were.

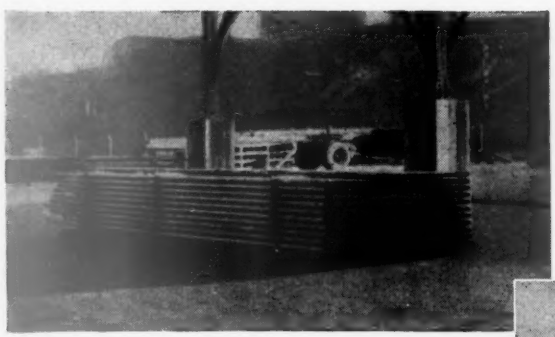
Aiding officially in the forum were R. A. Schell, National Supply Company; R. D. Hilborn, Jones and Laughlin Supply Company; John H. Lollar, Jr., Republic Supply Company, and A. B. Ripley, Republic Supply Company of California. Participating unofficially was a goodly proportion of the audience, led by Wendell Jones, Bethlehem Supply Company, and supported by Ted Sutter, Baker Oil Tools, Inc., Rodney Durkee, Lane-Wells Company, and Lou Bronzan, Baash-Ross Tool Company. As a result of the several discussions, it was well established that an altogether irrational amount of paper work was attributable to a very minor proportion of sales.

That something should be done about it was fairly unanimously agreed, but as to the method of doing that something, the agreement wasn't quite so noticeable. At the 1946 convention, held in Tulsa, four regional chairmen had been appointed to form their own committees on sales accounting, and were empowered to work with oil company purchasing agents in attempting to resolve the several difficulties involved. These committees concentrated on two objectives in particular: (1) The simplification of billing and accounting procedures covering "buy-outs" or sales between supply companies, and (2) the reduction and/or simplification of paper work covering the large volume of sales of small monetary value.

A transcription of the decisions and recommendations of these accounting committees, and a proposed method of handling inter-supply company transactions, was made available to all delegates just prior to the opening of the forum, and the lively discussion that was precipitated indicated that the subject was one of interest to most of the attending delegates. A number of representatives offered to try out the proposed system and report back at a later meeting. The handling of field stores and the complexities of billing from them; the difficulties of economically accounting for small frequent orders in preference to one blanket requisition, both were the subject of considerable debate. Meantime, Rodney Durkee summed up the general opinion very well when he stated that "any satisfactory revision or standardization of accounting procedures can only come as the result of a cooperative study by equipment suppliers' accountants and oil company purchasing agents and their accountants.

The afternoon of the first business day was given over to an address and open forum on industrial relations, the leading speaker being Frank Rehm, vice president, industrial relations, Shell Oil Company. Rehm presented a highly interesting discourse on the fundamental requirements of an adequate labor rela-

SERVICE PIPE PROBLEMS?



MANY LEADING UTILITIES STANDARDIZE ON HILL, HUBBELL COATED-AND-WRAPPED SERVICE PIPE!

- FACTORY APPLIED TO STANDARD SPECIFICATIONS
- CORROSION RESISTANT
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- ECONOMICAL
- EASILY STORED
- COMPLETE SIZE RANGE FROM ¾" NOM. AND UP

HILL, HUBBELL FACTORY APPLIED PIPE PROTECTION— is your protection against corrosion hazards common to pipe failures

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tions program, in which the keynote was defined as "understanding" — understanding of each others' problems by the various parties involved, and a willingness to give and take in attempting to arrive at solutions. Aiding the speaker in this exposition were Bob Roberts, Standard of California; Gardiner Blackman, Tide Water Associated Oil Company; A. H. Miller, Emsco Derrick and Equipment Company, and Ted Sutter, Baker Oil Tools, Inc.

The substance of the discussions on this subject ran the wide gamut of industrial and labor relations, from definitions of "closed shop," "union shop," "check-off," etc., to a rather unique description of a sizeable organization that has no union entanglements, hence no union problem of any sort. There was a spirited entry into the debate by various delegates, and the entire proceedings seemed to put everybody in fine fettle for the cocktail party that followed in the Red and Owl Rooms of the Bohemian Club.

Next morning everyone was up bright and early to hear Don Gilman, executive secretary of Western Oil and Gas Association, give one of his very fine dissertations on the subject of public relations —this time with particular respect to the part played by trade associations in the promotion or cultivation of desirable public attitudes. Among other things, the speaker emphasized that the trade association can do a great deal to preserve the American economy, by inspiring its members to acts and deeds that "secure better relations in all levels of industry," and coincidentally engender harmony and beneficial relations generally in its own ranks.

At the conclusion of the Tuesday morning session, the delegates were given the option of enjoying an afternoon of sight-seeing around San Francisco, or going to the horse races at Tanforan and taking a chance on being able to enjoy it.

On the morning of the final day, Wharton Weems, treasurer and general counsel of the PESA, reported on the condition of the institutional coffers, and showed with a barrage of figures that the association is in no danger of collapse from lack of funds. Rodney Durkee confirmed this after a close examination of the report, and offered some sage suggestions regarding the accounting system now employed, and regarding means of garnering further funds for the very worthy objectives of the organization. Following these disclosures and recommendations, Walter Pusch, who, by the way, should be patted on the back for a nice job of housing and transporting the western delegates, reported on the activities of the Pacific District office. Briefly, his plea was for more district meetings so that the members might derive more direct benefit from their affiliation.

H. R. "Bob" Safford Jr., executive secretary of the Petroleum Equipment Suppliers Association, then made his report, which consisted largely of recommendations for the future conduct of

LUNKENHEIMER VALVES
STAY TIGHT WITH LESS CARE

No business can afford wasteful, costly, production-lowering valve leakage. That's why it's always *good* business to maintain a regular check on valves, to make sure they are *tight* and in proper working order.... Maintenance men the nation over prefer Lunkenheimer Valves. They know from experience that these *quality-built* valves serve longer and better on the job—are easier to keep tight with a minimum of time, labor and expense.

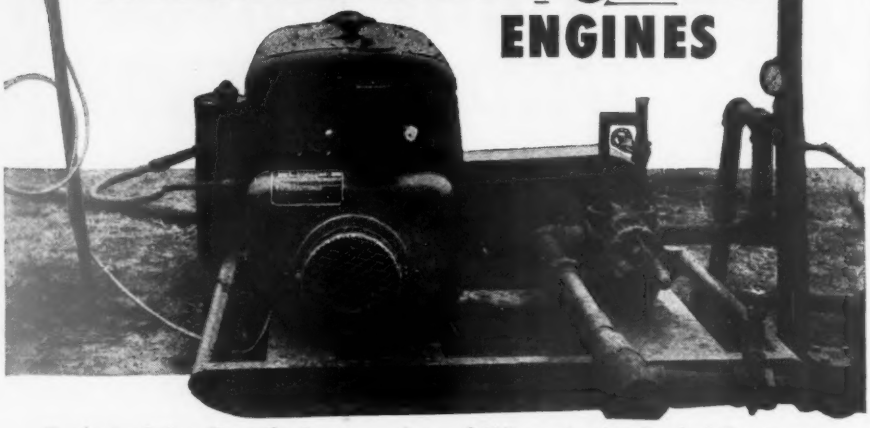
ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI 14, OHIO, U. S. A.

Fig. 123 "N-M-D" Globe (Non-Metallic Disc)
Fig. 2125 Bronze Gate
Fig. 16 "Renewo" Globe
Fig. 1640 "King Clip" Gate
Fig. 1430 Iron Body Gate
See Your LUNKENHEIMER DISTRIBUTOR for Better Valve Service
Lunkenheimer Distributors are located in principal industrial centers. There is one near you, fully equipped and ready at all times to assist with your valve maintenance, repair and operation (MRO) problems. Call on him!

Ask for Lunkenheimer chart showing costs of air, steam and water valve leakage.

LUNKENHEIMER VALVES
BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.;
BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

"Keep it Flowing" with DEPENDABLE
WISCONSIN Air-Cooled ENGINES



Typical of the diversified power duty of Wisconsin Air-Cooled Engines is this Model VE-4 pumping oil through the pipe line on a large oil field project in Oklahoma.
Wherever there is a real power job to be done within a 2 to 30 hp range, you can depend on Wisconsin Engines for heavy-duty service and complete freedom from cooling chores and troubles. You're sure of rugged dependability and serviceability if your equipment is "powered by Wisconsin". For further details consult Harley Sales Company.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air Cooled Engines

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510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

MERCOID

"DA" CONTROLS FOR PRESSURE OR TEMPERATURE IN EXPLOSION-PROOF HOUSING

Mercoid "DA" Controls are particularly suited for the accurate and dependable service required on many essential industrial applications.
The outside double adjustment feature permits setting of the control without removing the explosion-proof case cover. The accurately calibrated dial and pointers indicating the operating range, are plainly visible through the shatter-proof glass cover. The direct reading eliminates guesswork.
A heavy Bourdon tube actuates the mercury switch. The Mercoid corrosion-proof mercury switch assures positive make and break in the electrical circuit during years of continuous performance.
For complete data see Mercoid catalog No. 600. A copy will be sent upon request.

THE MERCOID CORPORATION • 4205 W. BELMONT AVE. • CHICAGO, ILL.

the association, and an outline of divers projects to which it should apply itself. Besides the various activities already discussed in the several forums, he especially urged as desirable aims for the consideration of the directors the following: (1) The issuance of a weekly bulletin or news letter, (2) the instigation of a pertinent market research program, (3) analyses of production, transportation, servicing, and other costs of interest to manufacturers and suppliers, (4) preparation of statistical reports on development of tools, (5) scheduling of district meetings for the discussion of local or general problems, (6) studies and reports on advertising media, and (7) the promotion of a public relations program. Other more or less incidental items suggested were the standardization of products or processes not already being taken care of by the API; the establishment of a credit bureau, or a clearing house for credit bureau information; and, finally, a membership campaign.

On the completion of the Safford report, Mason Jones, S. M. Jones Company, Toledo, Ohio, read the names of those selected by his nominating committee as directors. They were subsequently elected unanimously. The list is as follows: Eastern District: George H. Alten, Alten's Foundry and Machine Works, Lancaster, Ohio; Karl Elliott, Acme Fishing Tool Company, Parkersburg, West Virginia; Dave Fox, Branchland Pipe and Supply Company, Huntington, West Virginia; Jene Harper, Franklin Supply Company, Chicago, Illinois; Mason Jones, S. M. Jones Company, Toledo, Ohio; A. S. Knowles, Parkersburg Rig and Reel Company, Parkersburg; Donald W. Mackie, Bradford Supply Company, Bradford, Pennsylvania; Frederick F. Murray, Oil Well Supply Company, Dallas, Texas; A. W. McKinney, National Supply Company, Toledo, Ohio; Ferd J. Spang, Spang and Company, Butler, Pennsylvania; H. Bernard Wehrle, McJunkin Supply Company, Charleston, West Virginia.

Mid-Continent and Rocky Mountain District: W. M. Bovaird, Bovaird Supply Company, Tulsa, Oklahoma; H. B. Gutelius, United Supply and Manufacturing Company, Tulsa; W. H. Larkin, Larkin Packer Company, St. Louis, Missouri; Earl W. Miller, American Iron and Machine Works, Oklahoma City, Oklahoma; S. P. Wallace, Maloney-Crawford Tank Company, Tulsa; George Hays, Hinderliter Tool Company, Tulsa; Joe Eustace, W. C. Norris Mfgr., Inc., Tulsa; Walter O'Bannon, Walter O'Bannon Company, Tulsa; J. L. Shakely, Jones and Laughlin Supply Company, Tulsa; Guy Tompson, Bethlehem Supply Company, Tulsa; Jay P. Walker, National Tank Company, Tulsa; Carl White Jr., Franks Manufacturing Company, Tulsa.

Southwestern District: Lip Norvell, Norvell-Wilder, Beaumont, Texas; Allen Guiberson, Guiberson Corporation, Dallas, Texas; Rex Hamaker, Reed Roller Bit Company, Houston, Texas; Frank Hereford, Murray Brooks Incorporated, Lake Charles, Louisiana; Ardon B.

Judd, Republic Supply Company, Houston; E. L. Lorehn, Cameron Iron Works, Houston; K. W. Davis, Mid-Continent Supply Company, Fort Worth, Texas; Fred Mayer, Continental Supply Company, Dallas; Ralph Neuhaus, Hughes Tools Company, Houston; George O'Leary, Houston Oil Field Materials Company, Houston; W. B. Sharp, Mission Manufacturing Company, Houston; Wallace D. Wilson, Wilson Supply Company, Houston.

Pacific District: J. C. Axelson, Axelson Manufacturing Company, Los Angeles; Markley C. Brown, Hillman-Kelley Inc., Los Angeles; J. A. Crawford, Youngstown Steel Products Company, Los Angeles; E. S. Dulin, Byron-Jackson Company, Los Angeles; Rodney S. Durkee, Lane-Wells Company, Los Angeles; D. S. Faulkner, National Supply Company of California, Los Angeles; Hugh H. Glen, Emsco Derrick and Equipment Company, Los Angeles; H. E. Howard, Howard Supply Company, Los Angeles; Warner Parker, Oil Well Supply Company, Los Angeles; John J. Pike, Republic Supply Company of California, Los Angeles; Wendell Jones, Bethlehem Supply Company, Los Angeles; Ted Sutter, Baker Oil Tools, Inc., Los Angeles.

At a special luncheon meeting the newly elected directors in turn elected Ardon B. Judd, Republic Supply Company, Houston, and A. W. McKinney, National Supply Company, Toledo, Ohio, president and vice president, respectively, which to all intents and purposes ended the business sessions of the convention. When the names of the new officers had been announced to the membership, there was little left to do but repair to the cocktail party that had been arranged by the Pacific District members for the visiting delegates, and their friends in the oil industry.

This was in the nature of a grand windup, at which many friendships that had had their initial sproutings in the earlier sessions, blossomed into full being, and others of more ancient vintage were revived and strengthened. After it was all over, the president of a western equipment organization, who confessed that he had been somewhat reticent in the past, and consequently knew a very few of his business associates well, said, "Now, I feel as if I had known all these people for years." It was easy to see that he felt something else—the warmth that comes when a fellow discovers that he belongs to a pretty good gang, and merely needs to shed his own reticence to make his business associations vastly more enjoyable.

There you have one of the really substantial and noticeable accomplishments of the annual meeting of PESA. It broke down many inhibitions, dissipated a lot of misunderstanding, and brought closer together a business group that must operate in the closest harmony, if it is to serve to the maximum the great petroleum enterprise, in which from the very beginning it has been an active and indispensable partner.

New Completions,
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NOW I CAN DELIVER MY OIL!
IT'S A CINCH TO BOOST PRODUCTION WHEN I CLEAN THE OIL SAND
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If your well is on its "last legs" but should be doing better, study the reasons for its decreased production. Many cases point to clogging of the oil sand with hydrated clay. This is the material that Hi-Perm acts on. Treatment of oil sand with Hi-Perm opens up the pores for increased permeability. If there's oil in the sand, nothing can stop it from coming into the well. Wells cleaned with Hi-Perm stay cleaned longer.
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Lightweight one or two-cylinder heavy-duty, air-cooled models for maximum portability. Onan two, four and six-cylinder water-cooled plants for continuous operation, stationary or mobile.
ONAN ELECTRIC PLANTS—A.C.—350 to 35,000 watts in standard voltages and frequencies; D.C.—600 to 10,000 watts, 115 and 230 volts. Battery chargers—500 to 6,000 watts, 6 to 115 volts. ONAN AIR-COOLED ENGINES—CK: 2-cylinder opposed, 10 h.p.; BH: 2-cylinder opposed, 5.5 h.p.; IB: 1-cylinder, 2.5 h.p.
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ONAN ELECTRIC PLANTS

Cummins Engine officials

C. L. Cummins, founder in 1919 of the Cummins Engine Company, Inc., Columbus, Indiana, was elected chairman of the board of directors, and J. I. Miller was elected president of the company, at the 1947 annual meeting of stockholders and directors.

Cummins, recognized throughout industry as the pioneer in the development of the high-speed diesel engine, founded the firm in February, 1919, to build what was then called "the Cummins Oil Engine." At the time of its founding, the firm employed fewer than 20 persons whereas now there are more than 2000.

Miller joined the company in 1934 in the capacity of vice president and general manager and has been with the company continuously since that time except for the years 1942-44, when he served as a commissioned officer in the U. S. Navy aboard the USS Langley.

Other officers elected are: V. E. McMullen, executive vice president; R. E. Huthsteiner, vice president and general manager; H. L. Knudson, vice president of engineering; Carl R. Fox, vice president and works manager; D. C. Bottorff, secretary and treasurer; R. E. Lay, assistant secretary and assistant treasurer, and Edwin G. Crouch, assistant secretary.

Manager new division

Dennis F. McCarthy has been named manager of the new Tubular Goods Division of the A. O. Smith Corporation, Milwaukee, Wisconsin, a division that handles the manufacture and sale of steel pipe for oil and natural gas lines and oil-well casing. Although the company for many years has been one of the largest manufacturers of such products, the formal establishment of the new division represents a move toward greater efficiency in one of the company's major operations, officials state. McCarthy has been in the sales department of the company for 11 years and has been closely associated with the sale of tubular goods since 1938.

Name changed

At a stockholders' meeting held in Chicago recently the corporate name of the Galvin Manufacturing Corporation was officially changed to Motorola, Inc., effective May 15.

In making the change it was stated by Paul V. Galvin, president, "We feel that the word 'Motorola' has been so closely associated with us — our products and services — that there is great advantage from an advertising and merchandising angle in making this our legal title."

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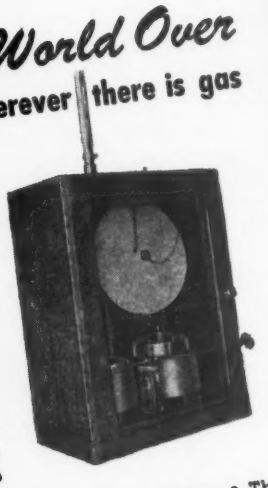

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A.S.T.M. meeting

In addition to the 20 formal technical sessions that are part of the technical program for the Fiftieth (1947) Annual Meeting of the American Society for Testing Materials in Atlantic City, June 16-20, inclusive, there will be more than 250 meetings of the society's technical committees. All sessions will be held at Chalfonte-Haddon Hall. There will be events under way morning, afternoon and evening of each of the days except the last day, Friday, June 20, when the closing sessions are scheduled for the afternoon.

More than 150 technical papers and reports by the country's leading authorities in the field of materials are scheduled, many of them being presented in connection with symposiums. On Monday evening, June 16, a symposium on load tests on bearing capacity of soils will be held. On Tuesday morning, June 17, there will be a symposium on methods of determining air entrainment in concrete, and in the afternoon a symposium on insulating oil will be held. On Wednesday afternoon, the eighteenth, there will be the symposium on synthetic lubricants, and at 4:30 the Edgar Marburg Lecture will be presented by Prof. W. C. Voss of Massachusetts Institute of Technology on "Engineering Laminates."

Another symposium to be held Thursday morning, June 19, will cover rubber testing, and there will be a round table discussion on water formed deposits on Thursday evening, and one on speed of testing Wednesday afternoon.

Several other sessions of the meeting will cover plastic deformation of metals (Thursday morning), fatigue of metals (Friday morning), plastics and wood (Friday afternoon), electrodeposited coatings and metal polishes (Wednesday morning), soils (Tuesday afternoon), cement and concrete (Tuesday evening), and steel (Thursday afternoon).

The annual address of the retiring president, Arthur W. Carpenter, is to be given at an annual meeting dinner on Wednesday night, June 18.

Coast sales manager

Kerotest Manufacturing Company of Pittsburgh, Pennsylvania, announces the appointment of James A. Norris as West Coast Division sales manager and the opening of new division offices at 315 West Ninth Street, Los Angeles 15, California.

Kerotest formerly occupied offices at 3305 East Slauson Avenue. Joseph A. Swaton and John H. Mueller will continue as West Coast field representatives.

Gas course curriculum

Curriculum for the second annual Short Course in Gas Technology at Texas A&I College has been announced by Dr. Frank H. Dotterweich, head of the A&I engineering department and chairman of the administrative committee for the course.

Sponsored by the Southern Gas Association, the course is scheduled for May 27-30, with enrollment, other than local, limited to 150. Included on the program are inspection trips to the King Ranch and to the Lower Rio Grande Valley.

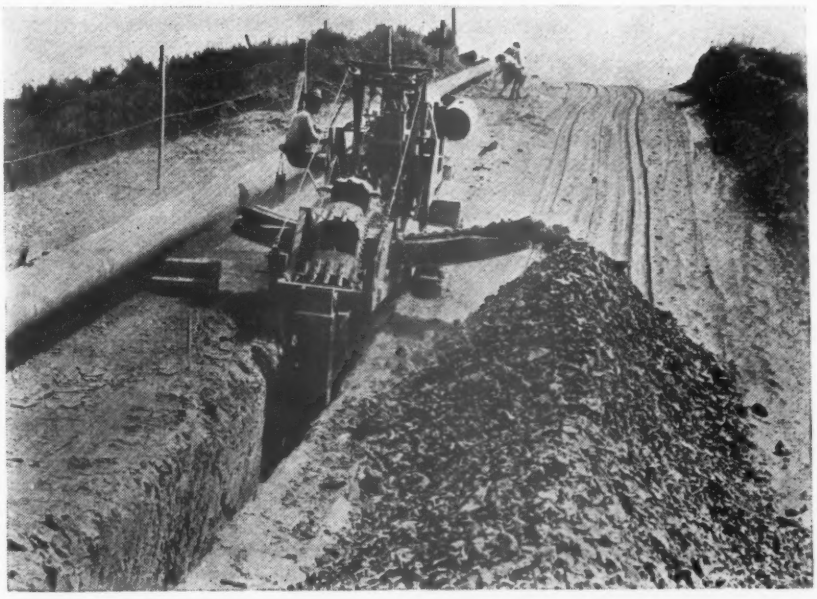
Twelve hours of classroom and laboratory instruction are being offered in each of the following subjects: (1) Technical problems of production and transmission, and (2) technical problems of gas utilization. A general assembly will be held on the first and last days to present speakers discussing trends in gas utilization and in natural gas research developments.

Classes in the production and transmission section will study pressure welding, backfills for sacrificial anodes, corrosion in condensate wells, improved methods of pipe line design, electrolytic models, and continuous well logging.

Utilization students will have presented these topics: Rice drying, dehydration of farm products, design and application of submergent gas burners, advanced design and application of all-year gas air conditioning equipment, dehydration and quick-freeze methods of food preservation, and special applications of natural gas.

Instructors will be members of industry and A&I faculty members.

CLEVELANDS



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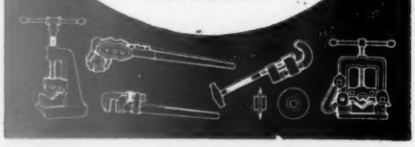

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New Cameron office and warehouse

Tad Putnam, manager of export sales for Cameron Iron Works, tells a group of interested California oil operators just how easy it is to change rams in the new Cameron Type "QRC" pressure-operated blowout preventer. The occasion was the house warming party given by Cameron Iron Works of California in Long Beach.

W. C. Norris officers

At the recent annual meeting of the stockholders of W. C. Norris, Manufacturer, Inc., Tulsa, Oklahoma, Edward C. Bolger was elected chairman of the board and William L. Butler executive vice president.

Bolger, for many years an executive with General Motors Corporation, returned to the United States in the spring of 1946 after four years' service in the Navy, where he was a lieutenant commander. He has since established residence in Tulsa.

Butler, who has been with W. C. Norris, Manufacturer, Inc., since 1935 in various executive capacities, has been advanced from secretary-treasurer to his present new position.

Export distributor

The Hinderliter Tool Company, Tulsa, Oklahoma, a division of H. K. Porter Company, Inc., of Pittsburgh, Pennsylvania, has announced the appointment of Baird Supply Company of New York as its export distributor for wellhead equipment, blowout preventers, rotary tool joints, and other related products. John H. Baird and Jack W. Askins, both well known in the oil field equipment export circles, are president and assistant manager, respectively, of Baird Supply Company. They maintain offices at 420 Lexington Avenue, New York 17, New York.

Adds Huber scrapers

The Bethlehem Supply Company has added Huber scrapers to its ever-increasing list of materials sold to oil country operators.

Huber scrapers are manufactured by J. M. Huber Corporation and are attached to Bethlehem sucker rods at their plant in Borger, Texas. Huber scrapers with automatic rotation are used to prevent paraffin accumulation in pumping wells. The Bethlehem Supply Company stocks Huber scrapers for 2-in. tubing in its stores in areas where paraffin is prevalent in pumping wells. Stocks are now available at Borger, Pampa, Sundown, and Houston in Texas, and Artesia and Hobbs in New Mexico. Huber scrapers for sucker rods to be used with 2½-in. tubing are also immediately available from Borger, Texas.

You're "Safe"
When You Carry
90-UL
ECOLITE

Don't wait — get this new Safety Lantern with BROKEN BULB EJECTOR!

SAFE
in Hazardous Places

Tested and Recommended by Underwriters' Laboratories.

Ecolite No. 90-UL

- Sealed beam construction.
- Throws bright beam 1500 feet.
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If You Worry About Feedwater Treatment Investigate SAND-BANUM

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20 Years and More

Sand-Banum has been safely and automatically doing this for hundreds of plants.

Guaranteed Harmless

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Write Today

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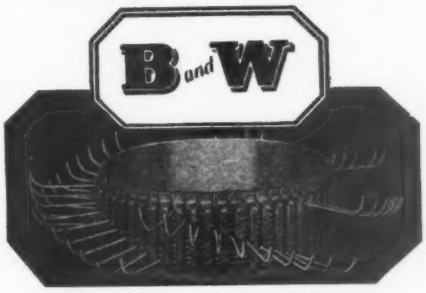

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HOUSTON, TEXAS • LONG BEACH, CALIF.

Crowell to new post

Alec M. Crowell, formerly with the Oil and Gas Division of the U. S. Department of the Interior, recently became affiliated with the Texas Eastern Transmission Corporation and is making his headquarters in Shreveport, Louisiana. His duties are the purchase of gas and the maintenance of gas reserves.

Alec M. Crowell

Crowell was educated at the universities of North Carolina and Kansas and began his association with the oil industry in 1925 with the Empire Oil and Refining Company. Early in 1930 he went to California for the Del Rey Oil Company and remained there until 1932, when he joined the staff of the Shamrock Oil and Gas Company and moved to Amarillo, Texas. From mid-1933 until early 1938 he was employed by the Oil and Gas Division of the Texas Railroad Commission. He was successively chief natural gas engineer and director of field engineering and research. In 1938 he was loaned to the State of Arkansas to organize the Arkansas Oil and Gas Commission.

The oil and gas operators of Mississippi employed him in January, 1945, to organize the Mississippi Oil and Gas Engineering Committee. Ralph K. Davies, then acting director of the Oil and Gas Division of the U. S. Department of the Interior, requested the Mississippi Oil and Gas Engineering Committee to loan Crowell to the government to serve in the capacity of director of the Conservation and Reserves Branch. He served from December 1, 1946, with the O.G.D. and represented the Department of the Interior on the Technical Petroleum Committee of the State Department, Interdepartmental Committee and Petroleum Committee of the United Nations Organization. He also arranged the National Secondary Recovery Forum which is being held jointly by the Interstate Oil Compact Commission and the Federal Government in Washington.

Crowell states that his principal work at the present time is to purchase flare gas in amounts shown in the tabulation below. He has four engineers in the State of Texas and two in the State of Louisiana making an independent survey of flare gas available.

BIG INCH:	M cu ft	M cu ft
Total requirements		300,000
Reserved for casinghead gas	75,000	
Deliveries at Jefferson	25,000	
Lone Star Gas at Carthage	25,000	
Lacy at Carthage	25,000	
United at Carthage	100,000	
Hunt at Harleton	25,000	
Whelan at Harleton	25,000	

LITTLE BIG INCH:	M cu ft	M cu ft
Total requirements		200,000
Reserved for casinghead	50,000	
Hunt at Lisbon	10,000	
Hunt at Lucky	20,000	
United at 24-in. tie-over	25,000	
Various purchases in Beaumont area	95,000	

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Quickly . . Easily . . with
CURTIN CENTRIFUGES

No. 3480. 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

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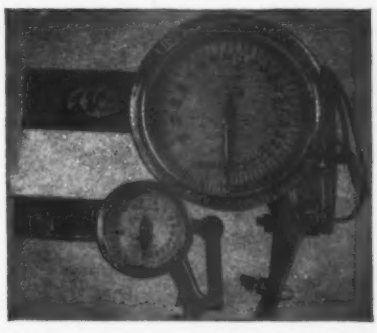
LINE SCALES



(Above) Super 500,000-lb. capacity, 14" dial. (Below) Packer Special, Capacity 40,000 lbs., 6" dial. 18 other models for every drilling, well servicing, or work-over need.

20 MODELS to choose from

With a LINE SCALE you know the pull on the line, and the weight on the bit in pounds. Repeated tests prove the accuracy and dependability of LINE SCALE readings under all working conditions . . . even in areas of rapid temperature changes.

LINE SCALE CO., Inc.
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EASY 1" TO 2"
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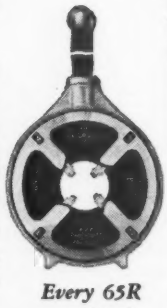
10 second adjustment to size instant-setting workholder

● You can't beat the self-contained semi-automatic 65R for speedy get-ready or smooth perfect threads. Its one set of high-speed steel dies adjust to pipe size in 10 seconds. Mistake-proof workholder sets instantly—one screw to tighten, no bushings to bother with. It cuts clean accurate 1" to 2" threads fast, with least work. Durable all-steel-and-malleable. Save time and effort—buy 65R at your Supply House.



Every 65R must cut a perfect thread before it leaves the factory.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

We breezed into the Pacific Coast Club at Long Beach not long ago for a luncheon date with Elmer Decker, who is so well known for his espousal of all things equestrian that when he stops at the St. Francis Hotel they always give him the bridle suite. Imagine our surprise upon arriving at the beach hostelry to find there assembled a blinding galaxy of civic luminaries; an imposing representation of oil industry field executives; a substantial delegation of drilling contractors, and a herd of dubious characters, called, with tongue in cheek, "gentlemen" of the press. They were all gathered in genial consort, we quickly learned, for the express purpose of launching that great event—the 1947 National Convention of the American Association of Oilwell Drilling Contractors, which will hold sway—and what sway!—in Long Beach, from October 13 to 15, day in and night out.

It seems, if we get the story correctly and we seldom do, that Ed Warren in a moment of aberration carelessly mentioned to Elmer Decker that the drilling contractors were looking for a suitable place to hold their next annual congregation. It may be said in defense of Mr. Warren that he had no idea at the time he spoke that Elmer was "that way" about Long Beach. However, if he didn't know then, it didn't take him long to find out, for immediately Elmer could see no reason why the drillers shouldn't convene in his back yard, and he kept on seeing no reason until he had either convinced the local and national officers, or had so exhausted them that they accepted his suggestion.

Having explained this—in somewhat different terms, of course—our host introduced the civic dignitaries, all of whom agreed to pitch in terrifically in order to keep up the standards set by prior convention cities, notably Dallas and Houston. The only dissenting vote came from Chief of Police Slater, who refused to head a "ticket squaring committee," but promised to help in every legitimate respect. Among the city officials, incidentally, was "Frosty" Martin, once partner in the firm of Martin-Decker, now chairman of the Long Beach Harbor Board. Frosty promised to bring to the convention a paper on the Harbor oil developments that have made Long Beach the richest city in the country.

The metaphorical gavel was then turned over to that prince of commuters, Ned Brown, who dashes back and forth between California and Saudi Arabia, with all the nonchalance of a man who is just going down to the street corner to mail a letter. Ned is a past president of the local chapter of Oilwell Drilling Contractors, besides being engaged in a dozen and one other interesting enterprises, that altogether keep him as busy as a Buff Orpington chicken with fly-paper on its foot. Recently he went back to Dallas as delegate from the home lodge, carrying its formal offer to host the 1947 donnybrook. The offer naturally was accepted, and Ned, as a reward for his accomplishment, has been given an important place on Karl Kellogg's central committee, which means that he will have to do a lot more work at no increase in salary. Oh, well, that's the penalty of popularity!

When called to his feet at the aforementioned luncheon, of which we have almost lost track once or twice during this discussion, Ned lost no time in presenting Brad Mills, national executive vice president of the A.A.O.D.C. Brad is a chap with a right pleasing personality, and he is rapidly becoming as well known and as highly respected in California as he is in his headquarter state of Texas. In his brief talk he blended ideal proportions of business and pleasure, examples of which were (a) his description of the evolution of contract drilling from the "shot in the dark" methods to its present extremely competitive, hence extremely precise status, and (b) his announcement that he expected there would be an unusually large delegation of women at the convention. As we understood it, the reasons for the latter situation were that any woman who hasn't yet basked in the eight-mile deep climate of California, is certainly not going to let her husband come to Long Beach alone,

and, by the same token, any woman who has once basked in this same climate, is certainly not going to miss a second opportunity.

A good advertisement for the healthful climate of the west was Will Reid, the Hancock prexy, who, with his white hair and well browned complexion, presented the appearance that easterners usually associate with Californians, but never can find when they get here. We would guess from sundry side remarks that Mr. Reid gets that sun-tanned look by frequent recourse to the same bridle trails that lure Elmer Decker, and it may have nothing to do with the subject, but we can't help mentioning here that the only time we personally ever came near to a proprietary interest in an equine, was once when we acquired a charley horse in a soccer game. But, to continue the narrative, Mr. Reid brought out rather neatly and pleasantly in a few extemporaneous remarks, that if conventions do nothing more than bring people together so that sharp differences of opinion are blunted by understanding, they are well worthwhile, and he pledged himself fully to the success of this particular convention.

Among other oil company representatives introduced were: Warren Johnston, Standard of California; S. F. Bowlby, Shell Oil Company; Bruce Robinson, General Petroleum Corporation; R. D. Montgomery, Richfield Oil Corporation; W. J. Travers, Richfield Oil Corporation; A. S. Baptie, Shell Oil Company; A. W. Gentry, Long Beach Oil Development Company; and W. A. Clark, The Texas Company. It was announced, incidentally, that the central committee, of which Karl Kellogg is chairman, is composed of the following in addition: E. C. Brown, Doug Graham, Ralph Marshall, Ed Simonis, and Gene Reid.

Doug Graham will be in charge of housing—a distinctly rugged assignment in these hectic days—for which the best qualification peculiarly enough is inn-experience. This recalls that during another California convention, we won't mention in which city for obvious reasons, a delegate was speaking to his hotel manager one night, and the latter quite casually but emphatically remarked, "This is easily the best hotel in the city." "Well," said the delegate, "That's a nice recommendation for the hotel, but it don't say much for the city." Then there was the delegate who asked the room clerk if he had special terms for oil men, and was told, "Yeah, but we dassent say them when they's women and children around."

Entertainment will be the responsibility of that famous Hibernian, George McCarthy, who still contends that half the lies they tell about the Irish are not true. Don't know what he has in mind, but would suggest an evening at that stirring melodrama, "The Drnukard." It might be very popular diversion. We were over there a few nights ago, and believe it or not, the pathos of the old play was so potent that by the end of the first act, there wasn't a dry throat in the house. Other, more typically Long Beach, amusement, and appropriate, too, would be a fishing job on a live bait boat, then in the evening a marshmallow roast, topped off with a grunion hunt.

It was rather to be expected that Ralph Marshall would be elected chairman of finance, because one of the most important things about a convention is that, after everyone has gone home and settled down, the finance chairman has to start in and settle up. Ralph is one of these orderly individuals who isn't flustered by pressure and, although a deal of this sort would excite most people atrociously, to him it is of such minor consequence compared with other deals he has handled, he will probably clean up the whole business some morning before he gets up.

The program committee is headed by Doc Hayes, and if Doc runs true to form, it will be quite a program. We presume that the function of this committee is to fit the various events together in logical sequence, like the tools on a drilling string, so as to complete the job with the least possible trouble and with the greatest possible return for the investment. That ought to be duck soup for an experienced campaigner like Doc, and we certainly expect him to organize a program that will produce oil—no dusters. After all, the convention is for drillers, not borers ,and you know what they say about after-dinner speakers —any one who doesn't strike oil in the first few minutes, should quit boring.

Slim Fowler will be in charge of transportation and thus has

RIDGID Pipe Cutter

is efficiently-balanced for clean speedy work

4-wheel No. 42 for fast quarter-turn cutting.

● This new style RIDGID is easy on your time and muscle; rolls through pipe extra fast, extra easily, leaving practically no burr. Made to toe the mark by its neatly balanced well designed malleable frame, the heavy-duty tool-steel wheel always cuts true. Every cutter is factory-tested. Choice of 5 sizes to 6" capacity, 4-wheel cutters to 4." You'll like this speedy work-saver—buy it at your Supply House.

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IMPROVED, COLLODIAL LUBRICATED PLASTIC

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the power to commander any idle vehicles for the use of the delegates. If, therefore, you should happen to be cruising in the vicinity of Long Beach harbor around October 13 to 15, and should have need to come ashore for any reason, better bring your cruiser along with you, otherwise, before you get back, it might be conscripted. Slim will also organize sight-seeing trips for those who might wish to see a sight or two, and will teach rugged individualists how they may make use of a beckoning thumb to secure their own transportation.

Gene Reid and his cohorts will be in charge of registration, which is a great privilege, because they will first take the names of the delegates as they come in, and will then tell them where they can go. We have often wished we could be a registrar just for a little while. There is one guy we would certainly like to be able to tell where to go, but that has nothing to do with this particular case, and we will thank you not to drag unconsequential matters into the conversation. The fact is that no convention could be run without a registration desk. For, if it could, how do you expect the secretaries of the committeemen would ever get to know how that man from Dallas looks—you know, the one that writes such nice letters to the boss.

The scandal of the event will be burned at both ends by that pair of outstanding publicists, Doug Graham, in the south, and Pug York, in the north, aided by their respective committees. They will see that newsworthy information is broadcast at frequent intervals to an eagerly awaiting world. They will also see that every oil hamlet in the United States is kept apprised of the behavior of its delegates, such of their behavior, that is, as may be publishable. It is whispered that they may even let loose an occasional bit of unpublishable stuff just to add spice to their releases. We have been told *sub rosa* that Pug York is an old newspaper man, but that he gave it up when he found there was no money in old newspapers.

Last but not least on the roster of committee chairman is Tom Pike. His will be the responsibility for assembling the succession of engineers, scientists, and statisticians, who will dilate on the economics and mechanics of contract drilling and all related subjects. Being of a technical turn of mind, Tom should fit admirably into this niche, and there is little doubt that he will do a bang up job. We would like to suggest that he run down the source of the persistent report that the Russians have drilled a 20-mile hole with some sort of electrical equipment, and get the author to explain how he keeps the tools from melting and running under the stove. That yarn is about on a par with the one about the farmer who trained his gophers to go straight down instead of sideways and they eventually rewarded him with a water well.

All of this shows just what can develop from one little luncheon, an innocent little luncheon, that was designed to start the convention ball a-rolling, and will give some idea of the barrage of words that is likely to burst forth when the convention itself actually gets a-rolling. Anyway, just by way of conclusion, herewith our congratulations to these inseparable sweethearts—Elmer Decker and Long Beach—on landing the first California convention of a growingly important organization — American Association of Oilwell Drilling Contractors.

Dr. Grebe receives Hyatt Award

Dr. John J. Grebe, director of Dow Chemical Company's physical research laboratory, Midland, Michigan, received the John Wesley Hyatt Award for outstanding achievement in the plastics industry during 1946. The 47-year-old chemist received the gold medal and $1,000, which comprise the annual Hyatt award, at ceremonies following dinner in the English and Michigan suite of the Hotel Statler, Detroit, Michigan.

Charles F. Kettering, vice president of General Motors Corporation and a member of the Hyatt Award committee, presented the award to Dr. Grebe for his work in the production of pure styrene and its polymerization. More than 70 persons attended the ceremony.

Servicing Horn tachometers

The Foxboro Company, Foxboro, Massachusetts, manufacturer of industrial instruments and, since 1908 exclusive representative in the United States for the Dr. Th. Horn Portable Tachometer, announces that all its facilities for the servicing of these instruments have been acquired by the James G. Biddle Company, 1316 Arch Street, Philadelphia 7, Pennsylvania.

• **Fundamental Research on Occurrence and Recovery of Petroleum, 1944-1945.** *Published and distributed by the American Petroleum Institute, 50 West 50th Street, New York 20. Pages, 156.*

Results of the work on Projects 37, 27 and 43 are published in this API Report of Progress. Project 37, "The Fundamentals of Hydrocarbon Behavior," directed by W. N. Lacey and B. H. Sage, covers the accomplishments since the publication of the 1943 research volume. In the summary by Lacey, he states "The volumetric behavior of the n-butane-carbon-dioxide system was determined" . . . "data for the various one-component and binary systems have almost all been compiled." Five papers dealing with various phases of this project follow.

Project 27, "Function of Water in the Production of Oil from Reservoirs," is summarized by F. E. Bartell, as follows: ". . . results of these investigations indicate that the behavior of crude oil systems studied in the laboratory may not be analogous to the behavior of these systems within their reservoirs, unless much care is taken to exclude all air."

"Transformation of Organic Material Into Petroleum," Project 43, is divided into three parts: 43a, "Transformation of Organic Material into Petroleum—Bacteriological and Sedimentation Phases"; 43b, ". . . Chemical and Biochemical Phases"; 43c, ". . . Physical and Physiochemical Phases." There are eight papers in this with a summary for each section.

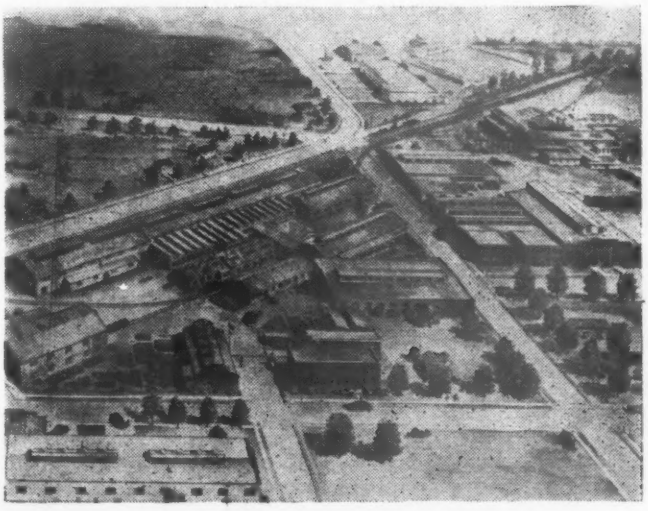
Lufkin gray iron foundry

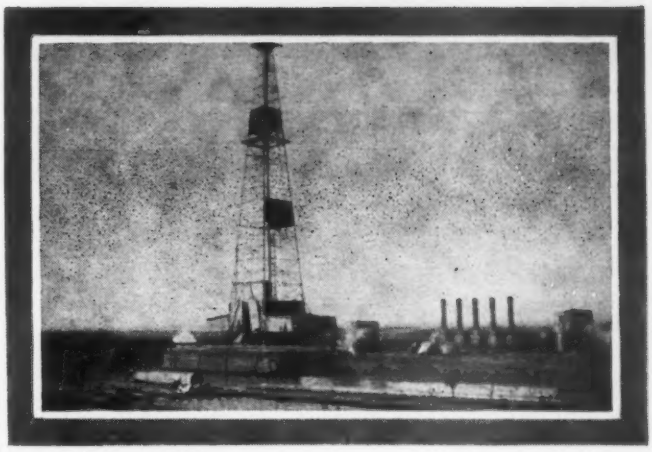
The new gray iron foundry of the Lufkin Foundry and Machine Company, Lufkin, Texas, was officially opened April 11 in connection with the Texas Chapter meeting of American Foundrymen's Association. The twofold occasion attracted foundrymen from Texas and Louisiana to the extent of some 200 registered visitors.

Among the out-of-state visitors were S. W. Wood of Minneapolis, president of the association; William Maloney of Chicago, secretary; Frank Steinebach of Cleveland, Ohio, editor of *Foundry* magazine; David Anderson of National Founders Association, Chicago; Roy Schumacher of Cincinnati, and Howard Nelson of Birmingham, Alabama.

The new foundry, situated in the center of a 68-acre tract, has a melting capacity of 160 tons per 8 hr. The main bay with four 10-ton cranes is 60 ft wide and 780 ft long. Two 70-ft cupolas, each capable of handling 20 tons an hr, are used on alternate days.

Artist's drawing of Lufkin Foundry and Machine Company. New gray iron foundry is in upper right corner.





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